Northwest Fisheries Science Center 3rd Science Symposium

What's Now & What's Next March 14-15, 2012

Symposium Abstracts

SYMPOSIUM AGENDA

Day 1 - Wednesday March 14, 2012

TIME	SPEAKER	ABSTRACT	TITLE
8:30-8:40	John Stein		Welcome and Introduction
THEME SUMMARY SESSION			
8:40-8:50	Kathi Lefebvre		Introduction to NWFSC Research Themes
8:50-9:15	Phillip Levin	1	Ecosystem approach to management for the California Current Large Marine Ecosystem
9:15-9:40	Beth Sanderson	2	Habitats to support sustainable fisheries and recovered populations
9:40-10:05	Jason Cope	3	Recovery, rebuilding and sustainability of marine and anadromous species
10:05-10:30	Brian Beckman	4	Sustaining marine ecosystem and human health
10:30-11:00	Everyone		Break/Poster Session
Theme Session: ECOSYSTEM APPROACH TO MANAGEMENT FOR THE CALIFORNIA CURRENT LARGE MARINE ECOSYSTEM			
11:00-11:15	Shallin Busch	5	Direct and indirect effects of ocean acidification on Puget Sound: insights from models and species response experiments
11:15-11:30	Dan Holland	6	Fishery income diversification and risk for fishermen and fishing communities of the West Coast
11:30-11:45	Dezhang Chu	7	Broadband acoustic characterization and classification of fish and zooplankton: an application towards ecosystem-based acoustic surveys
11:45-12:00	Jameal Samhouri	8	Risky business: linking land- and sea-based activities to risk in coastal ecosystems
	Rapid Fire Presentations		
12:00-12:08	Tom Wainwright	9	Does environmental information improve harvest management? – A coho salmon management strategy evaluation
12:08-12:16	Kelly Andrews	10	Ecosystem-level consequences of movement: the predatory impact of spiny dogfish in Puget Sound
12:16-12:24	Leif Anderson	11	Costs of delaying conservation: regulations and the recreational values of exploited and co-occurring species
12:24-12:30	Everyone		Questions for rapid fire speakers
12:30 – 1:30	Everyone		Lunch/Poster Session
Theme Session: HABITATS TO SUPPORT SUSTAINABLE FISHERIES AND RECOVERED POPULATIONS			
1:30-1:45	Casey Rice	12	Landscape patterns of lower to middle trophic level structure across natural and anthropogenic gradients in Puget Sound, Washington
1:45-2:00	Correigh Greene	13	Connectivity and estuary habitat use in juvenile fish: an analysis of tide gates in the Pacific Northwest
2:00-2:15	Lyndal Johnson	14	Habitat quality, toxics, and salmon in the lower Columbia River estuary: multi-year coordinated fish, fish prey, habitat and water quality data collection under the Ecosystem Monitoring Project
2:15-2:30	Waldo Wakefield	15	Information to support the five-year review of Essential Fish Habitat for Pacific Coast groundfish
	Rapid Fire Presentations		
2:30-2:38	Jason Miller	16	One hundred days in acidified water: potential impacts of low pH on early life stages of Dungeness crab *(Cancer magister)*
2:38-2:46	Dawn Noren	17	Using behavioral data to identify potential marine protected areas for the endangered Southern Resident killer whale
2:46-2:54	Julie Scheurer	18	Distribution and ecology of juvenile steelhead *(Oncorhynchus mykiss)* off the Oregon and Washington coasts
2:54-3:00	Everyone		Questions for rapid fire speakers
3:00-5:00	Everyone		Poster Session

SYMPOSIUM AGENDA

Day 2 - Thursday March 15, 2012

TIME	SPEAKER	ABSTRACT	TITLE
8:30-8:40	Mark Strom		Welcome and Introduction
Theme Session: RECOVERY, REBUILDING, AND SUSTAINABILITY OF POPULATIONS			
8:40-8:55	Krista Nichols	19	Genomics and the genetic architecture of migration/residency in *Oncorhynchus mykiss*
8:55-9:10	Laurie Weitkamp	20	Seasonal and interannual variation in juvenile salmonids and associated fish assemblage in open waters of the lower Columbia River estuary
9:10-9:25	Adam Luckenbach	21	Characterization of sexual differentiation and development of methods for sex control in sablefish, *Anoplopoma fimbria*
9:25-9:40	Eric Buhle	22	Forecasting risks of decline in salmon populations: an age-structured Bayesian approach
	Rapid Fire Presentations		
9:40-9:48	Mark Lomeli	23	Reducing Pacific halibut bycatch in the groundfish bottom trawl fishery
9:48-9:56	Larissa Rohrbach	24	Population-specific growth of yearling Columbia River Chinook salmon during early ocean residence and survival to adulthood
9:56-10:04	Donald VanDoornik	25	Genetic monitoring reveals genetic stability within threatened Chinook salmon populations in the Snake River
10:04-10:12	James Hastie	26	Summary of stock status for assessed Pacific Coast groundfish species
10:12-10:15	Everyone		Questions for rapid fire speakers
10:15-11:00	Everyone		Break
11:00-11:15	Brian Burke	27	Indicators of yearling Chinook salmon marine survival
11:15-11:30	Michelle Rub	28	A study to evaluate survival of adult spring/summer Chinook salmon migrating from the mouth of the Columbia River to Bonneville Dam
11:30-11:45	Joseph Anderson	29	Opportunities for recovery of Columbia River basin Chinook salmon and steelhead through reintroduction
11:45-12:00	John Pohl	30	Spatial distribution and abundance of adult Pacific hake *(Merluccius productus)* off the West Coast of North America in 2011
	Rapid Fire Presentations		
12:00-12:08	Paul Chittaro	31	Quantifying patterns of downstream movement in fall Chinook salmon
12:08-12:16	Benjamin Sandford	32	Examining the effects of juvenile migration timing on adult age of Columbia River salmon
12:16-12:24	Peter Lawson	33	Fine-scale Chinook salmon distributions in commercial ocean salmon fisheries
12:24-12:30	Everyone		Questions for rapid fire speakers
12:30-2:00	Everyone		Lunch
Theme Session: SUSTAINING MARINE ECOSYSTEM AND HUMAN HEALTH			
2:00-215	Vera Trainer	34	Phytoplankton as food for fisheries in the future ocean
2:15-2:30	Tish Conway-Cranos	35	Terrestrial-marine linkages in Puget Sound: trophic subsidies and oceanographic transport of freshwater, nutrients, and pathogens to shellfish beds
2:30-2:45	Kathi Lefebvre	36	A novel antibody-based biomarker for chronic algal toxin exposure and sub-acute neurotoxicity
2:45-3:00	Jeff Turner	37	Comparative genomics of clinical and environmental *Vibrio parahaemolyticus* reveals new markers for improved virulence detection in Washington State
3:00-3:15	Bich-Thuy Eberhart	38	Diarrhetic shellfish poisoning in Sequim Bay, Washington
3:15-3:30	Owen Hamel	39	Patterns of *Vibrio parahaemolyticus* concentrations in oysters, water, and plankton in Puget Sound
3:30-3:40	John Stein		Thank You and Conclude
3:40-5:00	Everyone		Poster Session/Removal

Northwest Fisheries Science Center 3rd Science Symposium

What's Now & What's Next March 14-15, 2012

Speaker Abstracts

Theme: ***Ecosystem Approach to Management for the California Current Large Marine Ecosystem: Science to move resource management toward a more holistic, ecosystem-based strategy***

1. Confronting the challenge of ecosystem-based management in the California Current

Phillip Levin

Conservation Biology Division
Northwest Fishery Science Center
Seattle, WA
Phil.Levin@noaa.gov

Ecosystem-based management (EBM) is an integrated approach to management that focuses on connections -- connections among the many ways we use, value, and benefit from the ocean. In this talk I will report on research conducted by natural and social scientists that has been instrumental in developing and synthesizing the scientific underpinnings of EBM and connecting that science to policy and practice. Integrated Ecosystem Assessments (IEAs) are an important analytical tool that supports EBM. IEAs use statistical analysis and ecosystem modeling to integrate a range of social, economic, and natural science data and information for discrete and often sectoral management objectives. This information can be used by managers and stakeholders for policy and decision-making, as well as for scientists who want to enhance their understanding of ecosystem dynamics. IEAs are designed to fill a critical information gap in achieving understanding about how individual management decisions affect all aspects of an ecosystem, not just the targeted management resource. The goal of an IEA is to better understand the complex web of interactions in an ecosystem and to forecast how changing environmental conditions and management actions affect this web.

Theme: ***Habitats to Support Sustainable Fisheries and Recovered Populations: Providing habitat science to sustain fisheries and recovered species***

2. Greeting the elephant in the room: our complex relationship with nonnative sport fishes

Beth L. Sanderson[1]*, Michael P. Carey[1], Katie A. Barnas[2]

[1]Fish Ecology Division
Northwest Fisheries Science Center
Seattle, WA
Beth.Sanderson@noaa.gov

[2]Conservation Biology Division
Northwest Fisheries Science Center
Seattle, WA

The introduction and establishment of nonnative fishes has contributed to the decline of native species worldwide. Many of the nonnative fish species in the western half of the United States were introduced to provide recreational fishing opportunities. Now widely distributed, these established nonnative sport fish populations may impede the conservation and recovery of native species. As the recreational fishing industry generates billions of dollars of revenue each year, federal and state agencies are caught between a rock and a hard place - they must jointly manage nonnative sport fishes that may in fact contribute to the decline of threatened and endangered species they also oversee. In the Pacific Northwest (PNW), there are more than 80 species of nonnative fishes, including a large number of popular recreational species. Many of the nonnative sport fishes are widely distributed. This is in part due to historical stocking practices which, over the past 40 years, have stocked at least 25 species of non-indigenous fish into Washington, Oregon, and Idaho. Once established, the impacts of sport fishes can vary widely and complicate management decisions. For example, predation estimates of smallmouth bass on juvenile salmon vary from 0 to 3.89 salmon consumed per smallmouth bass each day across locations in the PNW. A bioenergetics model of smallmouth bass consumption suggests the interaction of water temperature and timing of salmonid outmigration influences the magnitude of predation by smallmouth bass. Lessons explored for smallmouth bass can be applied to other non-native sport fishes in the Pacific Northwest.

Theme: ***Recovery, Rebuilding, and Sustainability of Marine and Anadromous Species: Conducting population science to manage harvest, recover endangered species, and rebuild overfished stocks***

3. Applied science for informed management: the supporting role of NWFSC science in Pacific west coast groundfish management

Jason Cope

Fishery Resource Analysis and Monitoring Division
Northwest Fisheries Science Center
Seattle, WA
Jason.Cope@noaa.gov

As appointed stewards of our nation's marine ecosystems, NOAA's National Marine Fisheries Service counts among its goals sustainable fisheries and recovered protected species. These goals prescribe a balance among the following objectives: maintenance of healthy fisheries, elimination of overfishing, rebuilding of overfished stocks, and increasing the long-term economic and social benefits to the nation. This complex task requires the comprehensive expertise of biologists, fisheries scientists, economists, social scientists, and policy analysts to help inform the Pacific Fishery Management Council's (PFMC) management decisions. This talk outlines one aspect of this process: how NWFSC data and analytical products provide science-based information critical to advising management actions in the socially, culturally, and economically important Pacific west coast groundfish fishery.

Theme: ***Sustaining Marine Ecosystem and Human Health: Understanding the links between the health of the environment, animals, and humans***

4. Physiological assessment of ecosystem status and habitat quality: examples based on insulin-like growth factor 1 of salmon

Brian Beckman[1*], Larissa Rohrbach[1], Shelly Nance[2], Deborah Harstad[1], Cheryl Morgan[3], Marc Trudel[4], and Bridget Ferriss[2]

[1]Northwest Fisheries Science Center
Seattle, WA
Brian.Beckman@noaa.gov

[2]School of Aquatic and Fishery Sciences
University of Washington
Seattle, WA

[3]Cooperative Institute for Marine Resources Studies
Oregon State University
Newport, OR

[4]Pacific Biological Station
Fisheries and Oceans Canada
Nanaimo, B.C.

Juvenile salmon are superb samplers of the marine environment. One of the primary motivations of these fish is to collect meal-sized portions of the planktonic food web. Salmon report the success of their explorations of the planktonic community by using the energy and nutrients obtained to grow. The short-term growth rate of juvenile salmon can be assessed through measures of the hormone insulin-like growth factor 1, obtained from blood samples of fish collected at sea. Salmon growth rate is a direct expression of the productivity of a given region/ecosystem and variation in growth reflects variation in ecosystem status. We have measured salmon growth in the Northern California Current annually since 2000. This 12-year time series demonstrates significant variation in marine productivity as salmon growth differs significantly between years. Surface ocean temperatures found in June during sampling are often near optimal for salmon growth (9–12^{o}C) and temperature variation has little apparent effect on salmon growth over this time series. An important facet of the marine ecology of salmon has been revealed by this work: ocean survival of juvenile salmon is positively and significantly correlated with early ocean growth. This relationship is shared across coho and Chinook salmon as well as steelhead trout, and has been found to specifically apply to Endangered Species Act-listed stocks such as Willamette and Snake River spring Chinook salmon. This sampling effort crosses the boundary between the California Current and Gulf of Alaska ecosystems and illuminates oceanographic processes structuring the status of the California Current and the ecosystem it supports. Variation in salmon growth rates from northern BC and Washington reflects variation in the North Pacific Gyre Oscillation (NPGO), an indicator of the oceanographic structure of the North Pacific Ocean. High values of the NPGO, indicating increased southward

transport of sub-arctic waters, are highly correlated with increased growth rates of salmon off the Washington Coast. Conversely, low values of the NPGO are correlated with higher growth of coho salmon in northern BC. These trans-ecosystem trends in salmon growth are helping to reveal basin-scale oceanographic processes that shape the productivity of the California Current Ecosystem.

5. Direct and indirect effects of ocean acidification on Puget Sound: insights from models and species-response experiments

Paul McElhany, D. Shallin Busch*, Mike Maher, Jason Miller, Sarah Norberg, and Jon Reum

Conservation Biology Division
Northwest Fisheries Science Center
Seattle, WA
Shallin.Busch@noaa.gov

Ocean acidification occurs as carbon dioxide produced by burning fossil fuels is absorbed by the ocean, forming carbonic acid and reducing pH in the ocean. It is anticipated that by the end of this century, carbon dioxide in the ocean will have at least tripled from pre-industrial times. Acidification can affect species that are sensitive to changes in pH, particularly organisms that form calcium carbonate structures, which can be more difficult to produce in acidified waters. About 30% of the species in Puget Sound form calcium carbonate structures including oysters, geoducks, sea stars, crabs, and many species of zooplankton. At the Northwest Fisheries Science Center, we estimate potential impacts of ocean acidification on Puget Sound through experiments on species which are potentially vulnerable to the direct effects of changes in pH and through food web modeling to explore potential indirect effects. Indirect effects occur when species that are not directly affected by acidification have a change in abundance because their predators or prey are directly or indirectly affected by acidification. Species-response experiments are used to detect and assess direct effects on potentially vulnerable species of economic, ecological, or conservation importance. The experiments are conducted by measuring the growth, survival and other relevant attributes of organisms grown in sea water that mimics pre-industrial, current, and projected future carbon dioxide concentrations. These experiments, conducted in a system uniquely suited to replicate the highly dynamic Puget Sound conditions and address interactions of acidification with other aspects of climate change (e.g., temperature and low oxygen), have been conducted on Pacific oysters, geoducks, two species of mussel, manila clams, Dungeness crab, copepods, krill, rockfish, surf smelt, herring, and ling cod, with more experiments in development. Results show that response to elevated carbon dioxide is mixed, with some species showing a negative effect and others showing no effect or even a positive response to elevated carbon dioxide. Data from these experiments and those from other labs were used to develop future scenarios for a food web model of Puget Sound which evaluate potential changes from acidification. The food web modeling indicates some potential declines in species of harvest and conservation concern in a high carbon dioxide environment. The

modeling also indicates that indirect effects may be relatively common as the effects of ocean acidification ripple through the food web.

6. Fishery income diversification and risk for fishermen and fishing communities of the West Coast

Dan Holland[1]* and Steve Kasperski[2]

[1]Conservation Biology Division
Northwest Fisheries Science Center
Seattle, WA
Dan.Holland@noaa.gov

[2] Resource Ecology and Fisheries Management Division
Alaska Fisheries Science Center
Seattle, WA

Catches and prices from many fisheries exhibit high inter-annual variability leading to variability in the income derived by fishery participants and communities dependent on the fisheries. The economic risk posed by this variability might be mitigated in some cases if individuals and communities participate in several different fisheries, particularly if revenues from those fisheries are uncorrelated or vary asynchronously. However, specialization in particular fisheries might be expected to yield higher profitability, and regulatory changes such as implementation of limited access and vessel and permit buybacks have made it more difficult for individuals to continue participating in a mix of fisheries. We construct indices of gross income diversification from West Coast and Alaskan fisheries. Indices are constructed at the level of individuals and fishing ports. We evaluate the relationship between variability of individuals' income and income diversification to determine whether income diversification appears to reduce financial risk. We also evaluate trends in income diversification and how they have been impacted by regulatory changes.

7. Broadband acoustic characterization and classification of fish and zooplankton: an application towards ecosystem-based acoustic surveys

Dezhang Chu

Fishery Resource Analysis and Monitoring Division
Northwest Fisheries Science Center
Seattle, WA
Dezhang.Chu@noaa.gov

To effectively conduct ecosystem-based acoustic surveys, the ability to identify, characterize, and classify multiple species is required. A broadband echosounder is able to record echoes from marine species including fish and zooplankton, as well as from other physical objects such as the seafloor and sea surface over a continuous and broad frequency band. Such acoustic systems have a number of advantages over the conventional narrow-band, discrete-frequency echosounders, including (1) high quality spectral information, such as quantitative characterization of acoustic resonance scattering from fish swimbladders; (2) much improved temporal-spatial resolution; (3) lower overall sidelobes; and (4) higher signal-to-noise ratio. Broadband acoustic technology has been used to characterize and classify different types of marine species (fish and zooplankton) that have different anatomy and material properties including air-bearing, fluid-like, hard shelled targets. In this presentation, the potential capability of the broadband technology to help identify and characterize multi- and mixed- species will be demonstrated and discussed.

8. Risky business: linking land- and sea-based activities to risk in coastal ecosystems

Jameal F. Samhouri[1,*], Kelly Andrews[1], Blake Feist[1], Mindi Sheer[1], Sophie DeBeukelaer[2], Rikki Dunsmore[2], and Phil Levin[1]

[1]Conservation Biology Division
Northwest Fisheries Science Center
Seattle, WA
Jameal.Samhouri@noaa.gov

[2]Monterey Bay National Marine Sanctuary
Monterey, CA

How urgent are the many and varied problems facing the oceans? In this talk, we will introduce a synthetic and efficient framework to identify land- or sea-based activities that pose the greatest risk to valued members of marine ecosystems. Ecosystem-based risk is scored along two axes of information: the exposure to an activity, and the sensitivity of the population to that activity, given a particular level of exposure. Risk is illustrated in a variety of ways, including two-dimensional contour plots and maps showing regional variation in risk. We apply this risk assessment framework on local and regional scales to ecosystem indicator species in Puget Sound and to habitats and species in Monterey Bay National Marine Sanctuary, CA. These two case studies highlight linkages between land-based activities and risk to marine species and show how the framework can be used to evaluate the potential impacts of a diversity of human activities on coastal oceans. The approach is scalable, transparent, and repeatable, and can be used now to facilitate the implementation of ecosystem-based management, including integrated ecosystem assessments and coastal and marine spatial planning.

9. Does environmental information improve harvest management? A coho salmon management-strategy evaluation

Tom Wainwright[1]*, David Rupp[2], and Pete Lawson[3]

[1]Fish Ecology Division
Northwest Fisheries Science Center
Newport, OR
Thomas.Wainwright@noaa.gov

[2]College of Earth, Ocean, and Atmospheric Sciences
Oregon State University
Corvallis, OR

[3]Conservation Biology Division
Northwest Fisheries Science Center
Newport, OR

The use of environmental and climate indicators has been widely advocated as a method of improving harvest management both directly (by incorporating indicators into quantitative stock assessments) and indirectly (via ecosystem-based management). There are examples where use of indicators has improved management-related forecasts, but there has been little evaluation of improvement in terms of achieving management goals. To investigate this, we used a management-strategy evaluation (MSE) approach involving Monte-Carlo simulations of population dynamics linked with harvest strategy implementation to assess the impacts of improving forecast skill under two types of strategies for managing the Oregon Coast Natural (OCN) coho salmon (*Oncorhynchus kisutch*) stock. The first strategy type uses the status quo two-variable decision matrix to determine harvest rate, and was developed as a precautionary approach to rebuild the OCN coho stock. The second strategy was a constant spawner escapement target, similar to that traditionally used for West Coast salmon management. We used two metrics of strategy performance: annual harvest and frequency of meeting critical spawner density criteria. We found the performance of the harvest matrix strategy to be largely insensitive to marine survival forecast skill, while the constant spawner escapement strategies were sensitive to adult abundance forecast skill. Our results imply that incorporating environmental variables to improve forecasts is not always useful; the benefits depend on both the general management strategy chosen and the level of precaution adopted in setting harvest targets.

10. Ecosystem-level consequences of movement: the predatory impact of spiny dogfish in Puget Sound

Kelly S. Andrews* and Chris J. Harvey

Conservation Biology Division
Northwest Fisheries Science Center
Seattle, WA
Kelly.Andrews@noaa.gov

The impact of predators in an ecosystem is directly related to how much time they spend in specific habitats and the manner in which they move throughout the environment. In order to investigate the predatory impact of spiny dogfish *Squalus suckleyi* in Puget Sound, we combined acoustic telemetry with bioenergetics modeling. We used large-scale arrays of passive acoustic receivers in Puget Sound and along the US West Coast to monitor the movement patterns of 17 spiny dogfish for up to four years. Spiny dogfish consistently entered Puget Sound in early summer, remained until late autumn, migrated through the Strait of Juan de Fuca and inhabited coastal waters (as far south as Long Beach, CA) the remainder of the year before returning to Puget Sound the subsequent summer. Individuals returning to Puget Sound showed remarkable consistency in the timing of movements into and out of Puget Sound across years. However, individuals varied in the duration of months spent in Puget Sound (2–7 months) and the ultimate destination within Puget Sound (50–120+km southward). We then constructed a bioenergetics model to calculate predatory impact based on consumption rates of the spiny dogfish population in each month of the year in Puget Sound. We compared models with and without the patterns of movement detected by acoustic monitoring. When patterns of movement are included, the annual predatory impact of spiny dogfish in Puget Sound was 53% lower than when movement is excluded. The strength of interspecific interactions is ultimately determined by the amount of time species interact and this analysis shows the importance of including movement patterns into any effort to quantify food web interactions.

11. Costs of delaying conservation: regulations and the recreational values of exploited and co-occurring species

Leif Anderson*, Todd Lee, and Phil Levin

Fishery Resource Analysis and Monitoring Division
Northwest Fisheries Science Center
Seattle, WA
leif.anderson@noaa.gov

Several species of rockfish (*Sebastes* spp.) in the Puget Sound of Washington have recently been listed under the Endangered Species Act. Bag limits for rockfish have been restricted as a result and recreational bycatch may prompt additional restrictions on trips targeting co-occurring species. Data collected in a recent survey of licensed anglers in Washington were used to estimate angler preferences for fishing trip attributes. These preferences are combined with creel survey data in order to simulate participation and economic value in the fishery under a series of regulations intended to conserve rockfish populations. Regulations that intend to limit rockfish bycatch mortality are shown to have economic impacts that are orders of magnitude larger than direct changes in rockfish bag limits or closures.

12. Landscape patterns of lower to middle trophic level structure across natural and anthropogenic gradients in Puget Sound, Washington

Casimir Rice*[1], Correigh Greene[1], Linda Rhodes[2], Jason Hall[1], Joshua Chamberlin[1], Kurt Fresh[1], and Hiroo Imaki[1]

[1]Fish Ecology Division
Northwest Fisheries Science Center
Seattle, WA
Casimir.Rice@noaa.gov

[2] Environmental Conservation/Resource Enhancement and Utilization Technologies Division
Northwest Fisheries Science Center
Seattle, WA

Inverse relationships between small pelagic fishes and jellyfish in coastal marine and estuarine ecosystems are increasingly reported around the world. These patterns are often assumed to be the result of human activity, despite considerable uncertainty about the true nature of the observed phenomena and their underlying causes. We sampled microbe, phytoplankton, zooplankton, and fish assemblages monthly in 2011 from April to October in surface waters across Puget Sound to examine how community composition varied across natural and human influences. We used a regression design that took advantage of spatial variation in land use within and across six oceanographic sub-basins of Puget Sound and four different geomorphic landforms within these basins. Sites varied from 0% to over 80% developed, although this range varied among sub-basins. We found strong latitudinal gradients in both fish and jellyfish biomass, as well as site dependent variation for some species. These findings were also paralleled in carbon and nitrogen stable isotope differences in tissues from fish and jellyfish, indicating both local and basin-wide influences. Together, these findings suggest that fish-jellyfish interactions may be influenced by local variation in land use as modulated by water residence time, but these patterns can be overshadowed by strong regional variation.

13. Connectivity and estuary habitat use in juvenile fish: an analysis of tide gates in the Pacific Northwest

Correigh Greene[1]*, Eric Beamer[2], and Jason Hall[1]

[1]Watersheds Program, Fish Ecology Division
Northwest Fisheries Science Center
Seattle, WA
Correigh.Greene@noaa.gov

[2]Skagit River System Cooperative
La Conner, WA

A number of restoration techniques can be used to counter widespread estuary habitat and connectivity loss across the Pacific Northwest, ranging from dike breaching and removal to installation of “fish-friendly” or self-regulating tide gates (SRTs). However, the physical and biological effects of these techniques have not been rigorously examined. In this presentation, we focus on the effects of SRTs, and examine their effectiveness in two different ways. First, we used a spatially extensive design to compare three site types: SRTs, flap gates, and unimpeded reference sites. Second, we used a temporally extensive design at three SRT sites to examine seasonal changes in upstream habitat areas and cumulative densities of Chinook salmon relative to downstream values, before and after SRTs were installed. In the spatially extensive study, we studied physical and biological metrics upstream and downstream of tide gates and at reference sites during three visits spanning the primary spring-summer fish rearing period. We found that site type appeared to affect a number of physical metrics including connectedness, water elevation, and temperature, but the degree to which each of these site types affected these physical metrics varied. In addition, densities of Chinook salmon (*Oncorhynchus tshawytscha*) and estuary rearing fish species were much greater at reference sites compared to sites with either flap gates or SRTs. For other species, densities were not different between reference sites and flap gate or SRT sites. In the temporally extensive study, the upstream/downstream ratio of Chinook salmon cumulative density at all SRTs was higher than at a traditional flap gate. The cumulative density ratio at one site increased 6-fold after a passive flap gate was replaced with an SRT, indicating that SRTs can improve habitat use by salmon. However, cumulative density ratios decreased 7-fold when a passive and manually manipulated side-hinged gate was replaced with a SRT, and this measure at all three SRT sites was an eighth to a tenth that of reference channels. Together, these findings indicate that SRTs vary substantially in performance, depending upon SRT design and the metric of interest. For estuarine-dependent species in general and juvenile Chinook salmon in particular, habitat use above SRTs is much less than in natural channels and

a little more than above traditional flap gates. For other anadromous salmon species that may spawn in creeks above tide gates, SRTs do not appear to strongly inhibit passage or juvenile rearing density.

14. Habitat quality, toxics, and salmon in the Lower Columbia estuary: multi-year coordinated fish, fish prey, habitat, and water quality data collection under the Ecosystem Monitoring Project

Lyndal Johnson[1]*, Paul Chittaro[2], Dan Lomax[1], Kate Macneale[1], O. Paul Olson[1], Sean Sol[1], David Teel[3], Gina Ylitalo[1], Catherine Corbett[4]

[1]Environmental Conservation/Resource Enhancement and Utilization Technologies Division
Northwest Fisheries Science Center
Seattle, WA
Lyndal.L.Johnson@noaa.gov

[2]Fish Ecology Division
Northwest Fisheries Science Center
Seattle, WA

[3]Conservation Biology Division
Northwest Fisheries Science Center
Seattle, WA

[4]Lower Columbia River Estuary Partnership
Portland, OR

Since 2005, NOAA Fisheries, the Pacific Northwest National Laboratory, and US Geological Survey have been collecting coordinated salmon, salmon prey, habitat, and water quality data in collaboration with the Lower Columbia River Estuary Partnership as part of their Ecosystem Monitoring Project. The Project's monitoring goals include understanding differences in habitat characteristics and patterns of occurrence of salmon and resident fish species among different reaches of the Lower Columbia Estuary, assessing temporal variability and year-to-year trends at the sites within each reach, and identifying factors that may be threats to salmon health and recovery. To date, sampling has been conducted at 21 sites in the Lower Columbia River, including multi-year monitoring at three sites, Campbell Slough on the Ridgefield National Wildlife Refuge, Franz Lake near Beacon Rock State Park, and Whites Island near Clatskanie, OR, to begin to document long-term trends in these habitats. While data are collected on occurrence and size distributions for all salmonid species, juvenile Chinook salmon have been our primary target species for the collection of detailed information on genetic stock, growth rate, lipid content, diets, and contaminant exposure. Our work over the past several years has shown that both saltwater and tidal freshwater habitats throughout the Lower Columbia support a variety of salmon species and stocks. However, there are distinctive patterns in fish community composition, salmon habitat occurrence, genetic stock composition, contaminant exposure, and other parameters, in each reach. Although a wide range of prey is available at the sampling sites, juvenile Chinook salmon throughout our study area preferentially consume aquatic fly larva and pupa (Diptera). These prey are more abundant in samples collected nearshore and associated with emergent vegetation, highlighting the importance of this habitat type for

food supply. We also noted that even at relatively undisturbed sites, there was evidence of human impacts that may affect salmon recovery. These include toxics, non-native species, dominance of marked hatchery stocks, and elevated summer water temperatures. Exposure to agricultural chemicals (e.g., DDTs) was common to both spring and fall Chinook salmon stocks, but fall Chinook stocks that spend some time feeding and rearing near urbanized areas of the estuary such as Portland and Vancouver had higher levels of industrial chemicals (e.g., PCBs and PBDEs). Our findings overall suggest that habitat restoration activities that preserve and enhance emergent vegetation, moderate summer water temperatures, reduce toxic contaminants, and control the spread of non-native fish species, may be beneficial to listed salmon in the Lower Columbia River.

15. Information to support the five-year review of Essential Fish Habitat for Pacific Coast groundfish

W. Waldo Wakefield[1*], Mary M. Yoklavich[2], Chris G. Romsos[3],Joseph J. Bizzarro[4], Curt E. Whitmire[1], and Marlene Bellman[5]

[1]Fishery Resource Analysis and Monitoring Division
Northwest Fisheries Science Center
Newport, OR
Waldo.Wakefield@noaa.gov

[2]Fisheries Ecology Division
Southwest Fisheries Science Center
Santa Cruz, CA

[3]College of Earth, Ocean, and Atmospheric Sciences
Oregon State University
Corvallis, OR

[4]School of Aquatic and Fishery Sciences
University of Washington
Seattle, WA

[5]Fishery Resource Analysis and Monitoring Division
Northwest Fisheries Science Center
Seattle, WA

The objective of this presentation is to provide a briefing on the status of Phase I of the Pacific Coast Groundfish Essential Fish Habitat (EFH) 5-year Review. In Phase I, we are determining the extent of new information available for the review and potential modification of current EFH designations. Initial EFH designations were based on the best available data that were assimilated and developed from 2002 to 2005; EFH designations were approved by NMFS in May 2006. Beginning in 2010, the Pacific Fisheries Management Council, NW and SW Fisheries Science Centers, and the NMFS Regional Offices initiated the first mandatory 5-year review for EFH provisions of the groundfish fishery management plan, and in this context, the Council formed an ad hoc EFH Review Committee. Phase I includes the evaluation of published scientific literature and unpublished scientific reports; solicitation of information from interested parties; and the review of previously unavailable or inaccessible data. Information will be updated on the distribution and extent of seafloor maps of bathymetry and interpreted groundfish habitat types; the distribution and extent of groundfish fishing effort; the distribution of biogenic habitat; spatial management boundaries; prey species for groundfishes; known or potential anthropogenic impacts to habitats (including groundfish prey); and habitat associations for 91 groundfish species. At the end of Phase I, the new information will be presented to the Council, its advisory bodies, and the public, and the Council will solicit proposals to modify EFH and Habitat Areas of Particular Concern (April 2012). The 5-year review represents a major update of the groundfish habitat assessment for the California Current and will have research and management applications well beyond satisfying the regulatory guidelines of Magnuson-Stevens Fishery Conservation and

Management Reauthorization Act. This presentation will highlight examples of key products developed for the 5-year review.

16. One hundred days in acidified water: potential impacts of low pH on early life stages of Dungeness crab (Cancer magister)

Jason Miller[1*], Sarah Norberg[1], Michael Maher[1], Phillip Schwabl[1], Daniel Bascom[2], Jenny Rempel[3], D. Shallin Busch[1], and Paul McElhany[1]

[1]Conservation Biology Division
Northwest Fisheries Science Center
Seattle, WA
Jason.Miller@noaa.gov

[2]University of Washington
Seattle, WA

[3]Stanford University
Palo Alto, CA

Dungeness crab (*Cancer magister*) is a commercially, culturally and ecologically important marine organism inhabiting coastal and estuarine waters of the Pacific Northwest. As a calcifying species, Dungeness crab may be susceptible to reductions in seawater pH brought about by changes in atmospheric carbon dioxide (CO_2) concentrations, termed ocean acidification. This study is the first in a series to explore the potential impacts of ocean acidification on early life stages of this species. Dungeness crab megalopae collected from north Puget Sound, WA were exposed to either control (400 μatm CO_2; n=86) or elevated CO_2 (1000 μatm; n=84) conditions. Survival, mortality, time to molt, carapace width (from molted carapaces), and physical characteristics were recorded for 110 days. By day 28, all surviving individuals had molted to the first instar stage. Survival to this stage was 96.5% in the control CO_2 treatment and 78.6% in the elevated CO_2 treatment. At the end of the experiment, all crabs had molted to the 4th, 5th or 6th instar. Preliminary analysis indicates that the duration of time individuals spent in each instar was similar between treatments (p=0.11, 0.34, 0.65 for 1st, 2nd, and 3rd instars respectively).

17. Using behavioral data to identify potential marine protected areas for the endangered Southern Resident killer whale

Dawn P. Noren* and Donna D.W. Hauser

Conservation Biology Division
Northwest Fisheries Science Center
Seattle, WA
Dawn.Noren@noaa.gov

Southern Resident killer whales (*Orcinus orca*) are listed as Endangered under the U.S. Endangered Species Act (ESA). Both vessel disturbance and reduced prey availability have been identified as risk factors. Previous studies found that vessel presence reduced foraging and resting behaviors in resident killer whales and dolphins, respectively. The designation of marine protected areas where vessels are prohibited is one potential mitigation measure to reduce disturbance. For maximum benefits, protected area designation should be prioritized in regions where these animals engage in critical behaviors, such as foraging and resting. To better understand Southern Resident killer whale habitat use patterns in their ESA-designated core summer critical habitat, GIS analyses were conducted on behavioral data collected during summer months in waters surrounding the San Juan Islands, USA. Travel was observed during 70%, forage during 21%, rest during 7%, and social behavior during 2% of 571 scans. Directionality, spatial arrangement, and configuration of whales varied significantly across the four behavior states ($P<0.0001$). Dive duration, surface duration, ratio of surface duration to previous dive duration, and swimming speed also varied significantly across behavior states ($P<0.001$). Differences in diving and swimming patterns as well as directionality and spatial arrangements indicate that these behaviors likely serve distinct functions for the whales. Most behaviors occurred throughout the study area, though the occurrence of certain behavior states and spatial arrangements tended to vary geographically. In particular, foraging and resting predominantly occurred in localized regions within the core summer critical habitat. These regions could be candidate marine protected areas where killer whales are protected from vessel traffic and other human activities.

18. Distribution and ecology of juvenile steelhead (Oncorhynchus mykiss) off the Oregon and Washington coasts

Julie A. Scheurer[1]*, Elizabeth A. Daly[2], Richard D. Brodeur[1], Laurie A. Weitkamp[3], and Brian R. Beckman[4]

[1]Fish Ecology Division
Northwest Fisheries Science Center
Newport, OR
Julie.Scheurer@noaa.gov

[2]Cooperative Institute for Marine Resources Studies
Oregon State University
Newport, OR

[3]Conservation Biology Division
Northwest Fisheries Science Center
Seattle, WA

[4]Environmental Conservation/Resource Enhancement and Utilization Technologies Division
Northwest Fisheries Science Center
Seattle, WA

Steelhead smolts (*Oncorhynchus mykiss*) migrate to the ocean in late-spring and early summer, and unlike other salmon species, they do not spend much time in the estuary and nearshore areas. Instead, they move quickly offshore to oceanic feeding grounds, bypassing the normal coastal migration route used by other salmon species. Steelhead are the third most abundant salmonid caught in May in our annual surveys off the coasts of Oregon and Washington, yet little is known about how they utilize early marine habitats and food resources, and how this might relate to survival. We analyzed diet, distribution, and growth data collected between 2000 and 2010 to address these unknowns, and to look for any differences between hatchery and wild fish. Juvenile steelhead were caught in low numbers at all stations, but mostly north of the Columbia River. They were consistently caught at the westernmost stations, indicating that we were not sampling at the western edge of their distribution. In general, fork length increased with distance offshore. Hatchery fish were significantly longer than unmarked fish in most years, yet the unmarked fish had better body condition. Overall feeding intensity has been above the 10-year mean during 2007-2010 and unmarked fish had more food in their stomachs relative to body weight than hatchery fish. The percentage of empty stomachs ranged from 2–17% per year, and unmarked fish had fewer empty stomachs than hatchery fish. Steelhead ate a wide variety of mostly neustonic prey. The main components of the diet were fish, euphausiids, and crab megalopae, accounting

for more than 85% of the diet across all years. Ongoing work will determine migration patterns, growth rates, prevalence of parasites, and otolith analysis. Future research needs will be presented.

19. Genomics and the genetic architecture of migration/residency in *Oncorhynchus mykiss*

Krista M. Nichols[1]*, Matthew C. Hale[2], Benjamin Hecht[2], Garrett McKinney[2], Jeff Hard[1], Ewann Berntson[1], Frank Thrower[3]

[1]Conservation Biology Division
Northwest Fisheries Science Center
Seattle, WA
Krista.Nichols@noaa.gov

[2]Department of Biological Sciences
Purdue University
West Lafayette, IN

[3]Auke Bay Laboratories
Alaska Fisheries Science Center
Juneau, AK

Though it is clear that both genes and environment play a role in determining the propensity and timing of migration in anadromous salmonids, the specific genetic factors that contribute to life history diversity remain to be identified. Whole genome approaches offer the tools to systematically evaluate which regions or genes in the genomes contribute to variation in life history traits. In a number of studies using both controlled crosses and natural populations, we have sought to identify the genes underlying the complex decision to migrate or stay (and associated traits) in *Oncorhynchus mykiss*, which includes the resident rainbow trout, and the migratory, anadromous steelhead trout. These studies, in concert, can tell us whether or not major genes responsible for phenotypic life history variation are the same or different within and among populations. Quantitative trait loci (QTL) studies and association mapping studies suggest that migration/residency and associated morphological and physiological traits are controlled by many genes of small effect. In some cases, the regions of the genome associated with these traits are in common across geographically distant populations, while in others, unique loci have been identified. In this talk, we will present results from QTL in two controlled crosses of *O. mykiss*, and compare those findings to preliminary results from an association genetics study in natural populations of *O. mykiss* from Little Sheep Creek, Oregon, and Sashin Creek, Alaska. The findings of these studies provide the foundation not only for understanding the proximate genetic factors influencing the decision to stay or go, but could ultimately contribute to models used to predict the fates of populations with variable life histories.

20. Seasonal and interannual variation in juvenile salmonids and associated fish assemblage in open waters of the lower Columbia River estuary

Laurie Weitkamp*[1], Paul Bentley[2], David Teel[3], and Marisa Litz[4]

[1]Conservation Biology Division
Northwest Fisheries Science Center
Newport, OR
Laurie.Weitkamp@noaa.gov

[2]Fish Ecology Division
Northwest Fisheries Science Center
Hammond, OR

[3]Conservation Biology Division
Northwest Fisheries Science Center
Manchester, WA

[4]Cooperative Institute for Marine Resources Studies
Oregon State University
Newport, OR

The transition between freshwater and marine environments is associated with high mortality for juvenile anadromous salmonids, yet even in major rivers like the Columbia little is known about this critical period. To address this deficiency, we have been investigating the estuarine ecology of juvenile salmonids and associated fish assemblage in open water habitats of the Columbia River estuary since 2007. In this talk, we'll describe some of the highlights of this project to date. We've found that all species of juvenile salmonids (Chinook, coho, sockeye, and chum salmon, and steelhead) exhibit an extremely consistent seasonal pattern of migration through the estuary, with species-, age class-, and stock-specific timing. Based on genetics and recovered fish tags, we determined that these salmon originate from all portions of the Columbia basin. Perhaps most surprising was our estimate that >90% of juvenile salmon were of hatchery origin. In contrast to predictable juvenile salmon, the abundance and composition of the greater estuarine fish assemblage was extremely variable and likely responding to dynamic physical conditions in the estuary. Comparisons to studies conducted three decades earlier suggest striking changes in the estuarine fish assemblage, likely in response to river flow alterations. This larger fish community likely serves an important role as alternate prey for juvenile salmon predators, and we are just beginning to understand have how such changes may impact juvenile salmon survival.

21. Characterization of sexual differentiation and development of methods for sex control in sablefish, *Anoplopoma fimbria*

J. Adam Luckenbach* and William T. Fairgrieve

[1]Environmental Conservation/Resource Enhancement and Utilization Technologies Division
Northwest Fisheries Science Center
Seattle, WA
Adam.Luckenbach@noaa.gov

Sablefish (*Anoplopoma fimbria*) represents a major fishery in the North Pacific and based on its high growth rate and market value, this species also has strong aquaculture potential. Female sablefish grow larger than males and thus there is interest in producing all-female and/or sterile stocks for aquaculture (i.e., sex control) to maximize growth rates and mitigate escapement risks. Nothing is known, however, about gonadal sex differentiation or the sex-determination system of sablefish. To gain a basic understanding of sex differentiation in sablefish we tracked early development of the gonads and also conducted a hormonal sex control experiment where juveniles were fed a diet containing a steroid, methyltestosterone (MT), as a first step toward defining the window when sex is labile and can be controlled. Juvenile sablefish were sampled at sizes ranging from 70–300 mm fork length (2–300 g body weight) to assess normal sex differentiation. Routine methods for paraffin histology were followed and gonads were sectioned at 5 μm. For the sex control experiment, fish were separated into three groups and provided feed containing 0 (control), 5, or 50 mg MT/kg from 76–195 mm (4.5–80 g). Feed rations were regulated over the 2-month experiment so that growth was similar across treatments. At termination of the experiment, 45 fish per treatment were sampled for gonadal histology and remaining fish were PIT-tagged to track growth and development. Early signs of sex differentiation were apparent beginning at 80 mm and animals could be unambiguously sexed by 120 mm. Ovarian differentiation was more obvious histologically, while differentiating testes generally remained quiescent, but showed increased vascularization and organization of spermatogonia into lobules. Fish treated with MT exhibited advanced spermatogenesis relative to size-matched control males. Gonads of control fish appeared normal and the male:female sex ratio was balanced (50:50), whereas gonads of MT-treated fish were classified as advanced testes (60%), ovotestes with advanced spermatogenesis (~30%), or sterile in appearance (~10%). These results suggested that MT successfully masculinized the juvenile sablefish. However, since ovotestes were observed in about 30% of the fish, it is likely that molecular events related to female differentiation had already been initiated prior to MT treatment. Any genetic females developing as phenotypic males that result from this study will aid in identifying the sex-determination

system of sablefish and could be valuable as future broodstock. In a follow-up sex control experiment, dietary MT as well as estrogen treatments were initiated in smaller sablefish (0.5 g) and preliminary results suggest that more complete phenotypic sex reversal was induced. This project provides the first information on early sexual development in sablefish, which is important for both fisheries management and aquaculture.

22. Forecasting risks of decline in salmon populations: an age-structured Bayesian approach

Eric R. Buhle[1]*, Rich W. Zabel[1], Mark D. Scheuerell[1], Mara S. Zimmerman[2]

[1]Fish Ecology Division
Northwest Fisheries Science Center
Seattle, WA
Eric.Buhle@noaa.gov

[2] Washington Department of Fish and Wildlife
Olympia, WA

Predictive models of population dynamics that can forecast the risk of decline or extinction are an essential tool in the conservation and management of imperiled species. Accurate estimates of uncertainty are an especially important component of such forecasts, because they allow decision-makers to weight the costs and benefits of various scenarios by their probability of occurrence. For Pacific salmon and steelhead (*Oncorhynchus* spp.), estimates of decline or extinction risk have often been derived from relatively simple age-structured or stock-recruit models and projected risk over time horizons of years to decades. By contrast, models used to forecast adult population size for salmon fishery management are typically based on relationships between the abundance of successive age classes within a cohort (so-called sibling methods) or between environmental covariates and juvenile-to-adult survival, and forecasts are on time scales of months to years. All of these approaches typically assume the age-specific transition rates are constant through time. Here we present an age-structured model that forecasts the abundance and age composition of adult spawners over short (e.g., 1–2 yr) time horizons based on annual estimates of juvenile (smolt) abundance. Smolt-to-adult survival is modeled as a function of environmental covariates (e.g., marine climate indices), and age-specific adult return rates are allowed to vary among cohorts. By using a Bayesian framework to fit the model to observed time series of smolts and adults, we obtain probability distributions of parameter estimates and forecasts. We illustrate the model's utility and potential applications with data from Snake River spring/summer Chinook (*O. tshawytscha*) and Puget Sound coho (*O. kisutch*) salmon. We also compare this approach to more traditional sibling regression models, and discuss some possible extensions to deal with more data-limited situations.

23. Reducing Pacific halibut bycatch in the groundfish bottom trawl fishery

Mark J. M. Lomeli[1*] and W. Waldo Wakefield[2]

[1]Pacific States Marine Fisheries Commission
Newport, OR
mlomeli@psmfc.org

[2]Fishery Resource Analysis and Monitoring Division
Northwest Fisheries Science Center
Newport, OR

Starting in 2011, the west coast limited entry groundfish trawl fishery began management under a Groundfish Trawl Rationalization Catch Share Program (Pacific Coast Groundfish Fishery Management Plan Amendments 20 and 21). This new program establishes annual catch limits and individual fishing quotas along with individual bycatch quotas. These complex fishery management measures have created increased demand for bycatch solutions in the groundfish trawl fishery. Currently, bycatch of overfished species in the west coast groundfish trawl fishery constrains the fishery such that a substantial portion of available harvest is left in the ocean. For many bottom trawl fishermen participating in this new program a major bycatch species of concern is Pacific halibut (*Hippoglossus stenolepis*), which is a prohibited take species with potential to constrain the fishery. In response to fishermen's concern over Pacific halibut bycatch, the National Marine Fisheries Service NW Fisheries Science Center in collaboration with the Pacific States Marine Fisheries Commission, and the fishing industry, tested the efficacy of a flexible sorting grate excluder designed to reduce Pacific halibut bycatch. The concept for this design is that fish smaller than the sorting grate openings will be retained, whereas fish greater than the sorting grate openings will be excluded from the trawl out an exit ramp. For this project a recapture net was used to quantify the escapement rates of target and non-target species. Results showed Pacific halibut bycatch was reduced numerically by 57% and gravimetrically by 62%. A significant difference in the mean total length was also noted between Pacific halibut caught in the trawl codend and the recapture net codend, with larger fish occurring in the recapture net. Retention of target species ranged from 77% to 90%. Results demonstrated the capability of a flexible sorting grate excluder to reduce Pacific halibut bycatch in the groundfish bottom trawl fishery.

24. Population-specific growth of yearling Columbia River Chinook salmon during early ocean residence and survival to adulthood

Larissa Rohrbach[1,2]*, David Teel[3], and Brian Beckman[2]

[1] School of Aquatic and Fishery Sciences
University of Washington
Seattle, WA
Larissa.Rohrbach@noaa.gov

[2]Environmental Conservation/Resource Enhancement and Utilization Technologies Division
Northwest Fisheries Science Center
Seattle, WA

[3]Conservation Biology Division
Northwest Fisheries Science Center
Manchester, WA

Growth of juvenile salmon during early ocean residence is a determining factor in their long- term survival to adulthood. Assessing growth rates of juvenile salmon along the coast of Washington and Oregon is of great interest in order to better predict smolt-to-adult return rate, especially for imperiled Columbia River Chinook salmon. Cell and tissue growth is stimulated by a protein hormone, insulin-like growth factor 1 (IGF-1), that is produced by the liver and secreted into the blood. The level of IGF-1, measured in the blood plasma is positively correlated with instantaneous growth, therefore it is an informative and robust index of growth in juveniles caught in their first 2–3 months at sea. In this study, IGF-1 levels in yearling Chinook caught along the Washington and Oregon coast in May and June from 2000 to 2011 were assessed. Variation in IGF-1 level was examined in relation to population, year, fish size, catch location, and month. Significant inter-annual differences were found, similar to earlier results presented on coho salmon. In addition, population-specific differences in IGF-1 levels were evident and consistent across years, requiring us to examine growth with regard to genetic and geographic origin of the fish, differences in freshwater migration timing, and month of capture at sea. Mean IGF-1 levels of lower Columbia/Willamette River spring Chinook salmon caught in May were correlated with adult returns to Willamette Falls Dam, whereas mean IGF-1 levels of upper Snake/Columbia River spring Chinook salmon caught in June were found to be correlated with adult returns to Bonneville Dam. These results suggest that the population-specific early marine growth of juvenile Chinook salmon is indeed related to adult survival and that IGF-1 levels of these fish may be used to predict population-specific adult returns.

25. Genetic monitoring reveals genetic stability within threatened Chinook salmon populations in the Snake River

Donald M. Van Doornik[1]*, Ewann A. Berntson[1], Steve Boe[2], Deb Eddy[3], Paul Moran[4], and Robin S. Waples[4]

[1]Conservation Biology Division
Northwest Fisheries Science Center
Manchester, WA
Don.Vandoornik@noaa.gov

[2]Confederated Tribes of the Umatilla Indian Reservation
Island City, OR

[3]Oregon Department of Fish and Wildlife
La Grande, OR

[4]Conservation Biology Division
Northwest Fisheries Science Center
Seattle, WA

Identifying and understanding temporal genetic changes within fish populations has important implications for the management of those populations, especially ones with conservation concerns. Such changes are often the result of genetic drift, which can be exacerbated when the size of a population decreases. Using molecular genetics techniques, we monitored seven Snake River Chinook salmon populations in Oregon to determine how the genetic characteristics within the populations have changed over time, and how those characteristics may have been affected by supplementation efforts. Levels of genetic diversity and effective population size estimates were calculated for samples collected over a 20-year time period, equating to a time span of about four generations. Overall, we found stable levels of genetic diversity in all of the populations examined, despite the fact that many of the populations exhibited periods of low effective population size. The lack of significant declines in these populations' levels of genetic diversity is encouraging given their conservation status as a threatened species.

26. Summary of stock status for assessed Pacific Coast groundfish species

James Hastie[1]*, Stacey Miller[2], Jason Cope[1]

[1]Fishery Resource Analysis and Monitoring Division
Northwest Fisheries Science Center
Seattle, WA
Jim.Hastie@noaa.gov

[2]Fishery Resource Analysis and Monitoring Division
Northwest Fisheries Science Center
Newport, OR

Over the past decade, an increasing number of species have been assessed using methods that allow stock status to be estimated. Some stocks have been found to be in need of rebuilding, and they have had a substantial impact on the management of all sectors of the groundfish fishery. Of these rebuilding stocks, those which have not yet reached rebuilding targets have exhibited continuing growth throughout this period (to the extent that the available data are adequate to discern a trend). A high percentage of the other assessed species, as of their most recent assessments, are either near or above their target levels of spawning potential. We summarize trends in the status of assessed Pacific Coast groundfish stocks over the last half-century, with particular focus on the recent rebuilding period. We will also highlight data, research, and methods that are needed to improve the number and quality of stock-status determinations that are available to inform future management.

27. Indicators of yearling Chinook salmon marine survival

Brian Burke[1]*, William Peterson[2], Brian Beckman[3], Cheryl Morgan[4], Elizabeth Daly[4], and Marisa Litz[4]

[1]Fish Ecology Division
Northwest Fisheries Science Center
Seattle, WA
Brian.Burke@noaa.gov

[2]Fish Ecology Division
Northwest Fisheries Science Center
Newport, OR

[3]Environmental Conservation/Resource Enhancement and Utilization Technologies Division
Northwest Fisheries Science Center
Seattle, WA

[4]Cooperative Institute for Marine Resources Studies
Oregon State University
Newport, OR

Most research on survival of juvenile salmon in the Columbia River Basin has focused on the freshwater environment. However, a growing body of evidence suggests that salmon year-class strength may be largely set during the early ocean life stage. We compiled data from 38 indicators of the marine environment (both biotic and abiotic) and combined them using two multivariate methods. Our goals were to 1) estimate the influence of these indicators on survival of yearling Chinook salmon from 2000–2010, and 2) create a model from which we could predict adult salmon returns up to two years into the future. The fitted model explained over 80% of the variation in adult yearling Chinook salmon abundance. The most important factors in the model related to bottom-up processes such as regional copepod and larval fish biomass estimates, individual fish diet and growth measurements, and measures of sea surface temperature. Given disparate marine spatial distributions among stocks of yearling Chinook salmon, model improvements could be achieved using stock-specific data.

28. A Study to evaluate survival of adult spring/summer Chinook salmon migrating from the mouth of the Columbia River to Bonneville Dam (rkm 234)

A. Michelle Wargo Rub[1]*, Lyle G. Gilbreath[2], Lila Charlton[2], Benjamin P. Sandford[3], and David J. Teel[4]

Fish Ecology Division
Northwest Fisheries Science Center
[1]Hammond, OR
[2]North Bonneville, WA
[3]Pasco, WA
Michelle.Rub@noaa.gov

[4]Conservation Biology Division
Northwest Fisheries Science Center
Manchester, WA

During their upstream-migration in the Columbia River basin adult salmon encounter several sources of mortality and delay. Some sources, such as harvest and dam passage, have been studied extensively and the information gained resulted in improved migration conditions and survival rates. Other potential sources of mortality, such as marine mammal predation remain to be empirically quantified. Predation by pinnipeds, most notably California sea lions (*Zalophus californianus*), Steller sea lions (*Eumetopius jubatus*), and harbor seals (*Phoca vitulina*) can be a significant component of mortality in the estuary, and lower river below Bonneville Dam. Populations of these marine mammals in the Columbia River and elsewhere in the US have increased significantly since passage of the Marine Mammal Protection Act in 1972. Today the total pinniped population in the lower Columbia River is estimated to be approximately 7,000. In 2010 and 2011, NOAA Fisheries began gathering data to evaluate marine mammal predation on adult salmonids during their migration in the lower Columbia River, a critical portion of their life history. We conducted a two-tiered mark/recapture pilot study, where returning adult spring Chinook salmon (*Oncorhynchus tshawytscha*) were tagged with passive integrated transponder (PIT) tags or with both PIT tags and acoustic transmitters. Study fish were captured, tagged, and released in the Columbia River estuary. Data from PIT tags provided an overall survival estimate from the estuary to Bonneville Dam (rkm 234). Acoustic tracking provided information about fish movement/residence within five subdivisions of the lower Columbia River. Genetic analysis of fin tissue was used to identify what of the nine genetic stock identification groups in the Columbia River basin these study fish represented. In both years the pilot study identified significant mortality that could not be explained by harvest or handling for Snake River and Upper & Middle Columbia River spring Chinook salmon. In 2010, 12% of the observed mortality for these groups was ‘unexplained’, and in 2011, ‘unexplained’ mortality was 11%. We suggest that marine mammal predation is responsible for these unexplained mortalities. Additionally, this work found that fish that had been implanted with active acoustic transmitters did not survive as well as those not tagged with transmitters, indicating a tag effect. Survival for acoustically tagged fish was 38% of the PIT-tagged only fish in 2010 and 17% of PIT-tagged fish in 2011.

Survival for fish that had been implanted with inactive or ‘dummy’ acoustic transmitters in 2011 was similar to that of the PIT-tagged fish, suggesting that the observed effect was not related to the tagging methods or to the presence of the tag.

29. Opportunities for recovery of Columbia River basin Chinook salmon and steelhead through reintroduction

Joseph H. Anderson[1]*, Michelle M. McClure[1],George R. Pess[2], Richard W. Carmichael[3], Michael J. Ford[4], Thomas D. Cooney[5], Casey Baldwin[6]

[1]Fishery Resource Analysis and Monitoring Division
[2]Fish Ecology Division
[4]Conservation Biology Division
Northwest Fisheries Science Center
Seattle, Washington
Joe.Anderson@noaa.gov

[3]Oregon Department of Fish and Wildlife
La Grande, Oregon

[5]Conservation Biology Division
Northwest Fisheries Science Center
Portland, Oregon

[6]Fish and Wildlife Department
Colville Confederated Tribes
East Wenatchee, WA

Local extirpations of Pacific salmon, due primarily to dams and other stream blockages, are common throughout the Pacific Northwest. Reintroducing salmon to habitat they historically occupied has substantial potential to promote recovery of Ecologically Significant Units (ESUs) listed under the Endangered Species Act. However, in order to measurably contribute toward recovery, reintroductions must enhance one or more of the four viability parameters used to evaluate ESUs and the populations within them: abundance, productivity, spatial structure, and diversity. Characterizing these benefits for specific populations will help prioritize among multiple options for recovery and inform implementation decisions such as selection of the source population. Reintroduction success will be constrained by a number of factors such as habitat quality and the number, size, and spatial arrangement of barriers. With significant help from a team of regional experts, we have systematically assessed areas that historically supported Chinook salmon and steelhead in the Columbia River basin and identified those where reintroduction, if carefully planned, could make significant progress towards viability. We will present several examples of locations we have identified as having the greatest potential for reintroduction to benefit recovery of threatened and endangered ESUs.

30. Spatial distribution and abundance of adult Pacific hake (*Merluccius productus*) off the west coast of North America in 2011

Rebecca E. Thomas[1], George Cronkite[2], Dezhang Chu[1], John E. Pohl[1]*, Stephen K. de Blois[1], Julia Getsiv-Clemons[3], Lisa A. Bonacci[3], Lawrence C. Hufnagle[1], Ken D. Cooke[2], Chris Grandin[2], Chelsea Stanley[2], and Alicia Billings[3]

[1]Fishery Resource Analysis and Monitoring Division
Northwest Fisheries Science Center
Seattle, WA
John.Pohl@noaa.gov

[2]Fisheries and Oceans Canada
Pacific Biological Station
Nanaimo, B.C.

[3]Fishery Resource Analysis and Monitoring Division
Northwest Fisheries Science Center
Newport, OR

The Pacific hake (*Merluccius productus*), an ecologically and commercially important groundfish species in the California Current ecosystem, is regularly monitored through a joint US-Canada acoustic survey. In 2011, the acoustic survey was conducted from mid-June through mid-September to estimate abundance and spatial distribution of the coastal Pacific hake stock shared by both countries. The survey covered the slope and shelf of the Pacific coast from 35.2°N to 54.9°N with most acoustic transects spaced 10–20 nm apart. Closed-net midwater trawls equipped with a camera system were conducted to verify size distribution and species composition and to obtain biological information (i.e., age composition, sex). Aggregations of Pacific hake were detected along the continental shelf break from just north of Monterey Bay (37°N) to the southern Haida Gwaii Islands. The highest concentrations of Pacific hake were observed off Cape Mendocino. The coastal Pacific hake stock surveyed in 2011 was dominated by age-3 individuals. Pacific hake numbers off the west coast were low relative to previous years. Implications of our findings regarding the status and trends of Pacific hake will be discussed.

31. Quantifying patterns of downstream movement in fall Chinook salmon

Paul Chittaro[1]*, Rich Zabel[1], Jens Hegg[2], and Brian Kennedy[2]

[1]Fish Ecology Division
Northwest Fisheries Science Center
Seattle, WA
Paul.Chittaro@noaa.gov

[2]University of Idaho
Fish and Wildlife Resources
Moscow, ID

Effective management and conservation of imperiled species requires an understanding of habitat use and movements patterns between habitats. Anadromous fishes such as Pacific salmon undergo large migrations between freshwater and marine habitats, which coincide with specific life-history transitions. In a study of ESA-listed Snake River Chinook salmon, we used otolith microchemistry, specifically strontium isotope ratios (87Sr/86Sr), to characterize seaward migration patterns (timing and location) among juveniles. We then applied a multivariate time series model (Dynamic Factor Analysis) to identify groups of fish with similar migration patterns. Lastly, we used otolith microstructure (i.e., daily and annual increments) to estimate somatic growth of each fish, and statistically compare growth among identified groups to assess whether any pattern of migration was associated with greater performance.

32. Examining the effects of juvenile migration timing on adult age of Columbia River salmon

Benjamin P. Sandford

Fish Ecology Division
Northwest Fisheries Science Center
Pasco, WA
Ben.Sandford@noaa.gov

Salmon production is highly affected by dynamic changes in the ocean environment. Both intra- and interannual differences in water temperature and food web structure can create large differences in growth and survival within and among year classes. These differences lead to changes in age structure and relative stock contribution, thus affecting population and species viability. In recent years, large numbers of juvenile yearling Chinook salmon and steelhead from the Columbia River have been tagged with Passive Integrated Transponder (PIT) tags prior to migration to the Pacific Ocean. We used information from these tagged fish to estimate how adult age, as measured by year-of-return proportions (YORs), varied as a function of juvenile seasonal migration timing, year, and migration route (i.e., bypass and transportation history). We considered wild spring/summer Chinook salmon tagged at or above Lower Granite Dam on the Snake River from 1998 to 2008. Using ordinal logistic regression, we found clear patterns in YORs versus time of arrival below Bonneville Dam. We found a general pattern indicating that fish migrating later returned as older adults. However, there was definite interannual variation in YOR proportions. Coupled with the observation of variable interannual adult return rates, these analyses highlight how seasonal and annual changes in the estuarine and nearshore environment can translate into important differences in salmon survival. We compared our survival data to ocean indices to begin to explore possible causes of these patterns.

33. Fine-scale Chinook salmon distributions in commercial ocean salmon fisheries

Peter Lawson[1]* and Paul Moran[2]

[1]Conservation Biology Division
Northwest Fisheries Science Center
Newport, OR
Peter.W.Lawson@noaa.gov

[2]Conservation Biology Division
Northwest Fisheries Science Center
Seattle, WA

Project CROOS (Collaborative Research on Oregon Ocean Salmon) and the West Coast Salmon Genetic Stock Identification (GSI) Collaboration have been employing fishermen to sample troll-caught Chinook salmon at sea since 2006. In 2010 and 2011 sampling was distributed throughout the fishing season in Oregon and California, yielding a unique, fine-scale map of stock-specific salmon distributions over a wide area. These data can be used to analyze migration patterns and relative abundances, and to relate catch distributions to changing oceanographic conditions. Fishery management relies on the ability to target fishing on strong stocks while reducing bycatch of weak stocks. Fine-scale GSI data can be used to refine the coarse-scale, coded-wire-tag data and may enable fisheries to be shaped in response to short-term variations in stock distributions. Data from 2010 and 2011 are used to demonstrate some of the variability that is present in stock distributions and to explore analytical techniques that are being developed.

34. Phytoplankton as food for fisheries in the future ocean

William P. Cochlan[1], Vera L. Trainer[2]*, Charles G.Trick[3], Mark L. Wells[4]

[1]Romberg Tiburon Center for Environmental Studies
San Francisco State University
Tiburon, CA

[2]Marine Biotoxins Program
Northwest Fisheries Science Center
Seattle, WA
Vera.L.Trainer@noaa.gov

[3]Western University
London, Ontario, Canada

[4]University of Maine
Orono, ME

Eastern boundary current upwelling systems harbor a major portion of the marine fisheries that support humankind, and these sites are forecast to experience extreme ocean acidification into the next century due to the combination of increasing atmospheric CO_2 and shallowing of organic matter remineralization. The more extreme pH changes in these productive waters likely will have impacts on trace metal (particularly iron) and nitrogen availability, causing potential shifts in phytoplankton species composition and physiology. One understudied aspect of ocean acidification is the stress related to changes in synthesis of total lipid and polyunsaturated fatty acids (PUFAs), needed to support production at higher trophic levels where most organisms lack the ability to produce these compounds. The effect of extreme ocean acidification will change phytoplankton community composition, thereby influencing total lipid production and the amount and composition of PUFAs. An assessment of these effects in boundary current regions is important in our understanding of the comparative food quality of future phytoplankton communities and will provide critical information required by fisheries modelers who are concerned with understanding the quality of the links between phytoplankton communities and food chain success.

35. Terrestrial-marine linkages in Puget Sound: trophic subsidies and oceanographic transport of freshwater, nutrients and pathogens to shellfish beds

Letitia (Tish) Conway-Cranos[1]*, Peter Kiffney[2], Neil Banas[3], Mark Plummer[4], Sean Naman[1], Krista Bartz[4], Mary Ruckelshaus[5], Rohinee Paranjpye[6], Mark Strom[6], Parker MacCready[7], John Bucci[8]

[1]Frank Orth and Associates
Northwest Fisheries Science Center
Seattle, WA
Tish.Conway-Cranos@noaa.gov

[2]Fish Ecology Division
Northwest Fisheries Science Center
Seattle, WA

[3]Applied Physics Laboratory
University of Washington
Seattle, WA

[4]Conservation Biology Division
Northwest Fisheries Science Center
Seattle, WA

[5] The Natural Capital Project
Stanford University
Stanford, CA

[6]Resource Enhancement and Utilization Technologies Division
Northwest Fisheries Science Center
Seattle, WA

[7]School of Oceanography
University of Washington
Seattle, WA

[8]Department of Natural Resources and the Environment
University of New Hampshire
Durham NH

Shellfish are a key component of the nearshore ecosystem in Puget Sound and are affected by a suite of natural and anthropogenic processes occurring in freshwater and marine ecosystems. For example, the delivery of subsidies to shellfish beds is likely determined by a combination of variables such as precipitation, water temperature, and ocean circulation, as well as watershed land use adjacent to nearshore habitats. Our objective is to use oceanographic modeling and stable isotope analyses to determine the physical and biological extent of freshwater and marine influences to three shellfish growing areas in Puget Sound: the Dosewallips, the Hamma Hamma and Samish Bay. Each of these locations supports large, commercially harvested shellfish populations, but exhibits variation in land use (e.g., forested, agriculture), and nearshore productivity and water temperature. First, we use a fine-scale three-dimensional oceanographic circulation model (MoSSea) to examine the physical transport of freshwater to each shellfish growing area. Second, we examine the isotopic signature ($\delta^{13}C$ and $\delta^{15}N$) of the Pacific oyster, *Crassostrea gigas*, collected from all three growing areas to determine the relative contribution of freshwater and marine subsidies to shellfish diets. Potential diet items include phytoplankton, intertidal macrophytes (seaweeds and eelgrass), salt marsh plants, and upland vegetation. Finally, we will determine the sensitivity of nearshore shellfish populations to exposure of varying levels of freshwater and marine-derived nutrients and pathogens under alternative scenarios. Likely

economic and ecological consequences of these various scenarios on shellfish populations will also be assessed. Because shellfish populations depend upon the delivery of uncontaminated water originating from both land and sea, understanding the relative importance of freshwater and marine influences to shellfish beds is an important aspect of sustainable management of watersheds and near-shore ecosystems.

36. A novel antibody-based biomarker for chronic algal toxin exposure and sub-acute neurotoxicity

Katherine A. Lefebvre[1]*, Elizabeth R. Frame[1], Frances Gulland[2], John D. Hansen[3], Preston S. Kendrick[1], Richard P. Beyer[4], Theo K. Bammler[4], Fred M. Farin[4], Emma Hiolski[5], Don Smith[5], Mark S. Myers[1], Dave J. Marcinek[6]

[1]Environmental Conservation/Resource Enhancement and Utilization Technologies Division
Northwest Fisheries Science Center
Seattle, WA
Kathi.Lefebvre@noaa.gov

[2]The Marine Mammal Center
Sausalito, CA

[3]Western Fisheries Research Center
United States Geological Survey
Seattle, WA

[4]Department of Environmental and Occupational Health Sciences
University of Washington
Seattle, WA

[5]Microbiology and Environmental Toxicology
University of California at Santa Cruz
Santa Cruz, CA

[6]Departments of Radiology and Bioengineering
University of Washington
Seattle, WA

The neurotoxic amino acid, domoic acid (DA), is naturally produced by marine phytoplankton and presents a significant threat to the health of marine mammals, seabirds, and humans via transfer of the toxin through the foodweb. In humans, acute exposure causes a neurotoxic illness known as amnesic shellfish poisoning characterized by seizures, memory loss, coma, and death. Regular monitoring for high DA levels in edible shellfish tissues has been effective in protecting human consumers from acute DA exposure. However, chronic low-level DA exposure remains a concern, particularly in coastal and tribal communities that subsistence-harvest shellfish known to contain low levels of the toxin. Domoic acid exposure via consumption of planktivorous fish also has a profound health impact on California sea lions (*Zalophus californianus*), affecting hundreds of animals yearly. Due to increasing algal toxin exposure threats globally, there is a critical need for reliable diagnostic tests for assessing chronic DA exposure in humans and wildlife. Here we report the discovery of a novel DA-specific antibody response that is a signature of chronic low-level exposure identified initially in a zebrafish exposure model and confirmed in naturally exposed wild sea lions. Additionally, we found that chronic exposure in zebrafish caused increased neurologic sensitivity to DA, revealing that repetitive exposure to DA well below the threshold for acute behavioral toxicity has underlying neurotoxic consequences. This sub-acute neurotoxicity further emphasizes the need for a diagnostic test for chronic DA exposure. The discovery that chronic exposure to low levels of a small, water-soluble single amino acid triggers a detectable antibody response is surprising and has profound implications for the development of diagnostic tests for exposure to other pervasive environmental toxins.

37. Comparative genomics of clinical and environmental *Vibrio parahaemolyticus* reveals new markers for improved virulence detection in Washington State

Jeffrey W. Turner[1,2]*, Chris Berthiaume[2], Rhonda Morales[2], Stanley Biryukov[1], E. Virginia Armbrust[2], Mark S. Strom[1]

[1]Northwest Fisheries Science Center
Seattle, WA
Jeff.Turner@noaa.gov

[2]Center for Environmental Genomics
School of Oceanography
University of Washington
Seattle, WA

Vibrio parahaemolyticus is a gram-negative bacterium indigenous to coastal marine waters and the leading cause of seafood-borne gastroenteritis worldwide. The prevention of *V. parahaemolyticus* infection relies largely on screening seafood for the thermostable direct and related hemolysin genes (*tdh* and *trh*). In Washington State, a prevalence (88.9%, 24/27) of tdh^+ strains among environmental multilocus sequence types has diminished the utility of *tdh* and highlights the need for research aimed at the improved detection of virulent strains. To that end, we present the SOLiD sequencing of clinical (N=13) and environmental (N=6) *V. parahaemolyticus* isolated from Washington State. Pair-end reads were assembled *de novo* using VELVET followed by SOPRA scaffolding to yield an average 809 scaffolds per genome, ranging from 100 to 101,811 bp. Scaffolds were then annotated in RAST as draft genomes. Of special interest, strains representing two emergent tdh^- clinical sequence types (100%, 3/3), share adjacent *hly*A (605 amino acids), *hly*B (708 amino acids) and *hly*D (479 amino acids) genes homologous (83, 92 and 81% identity, respectively) to the *hly*A, *hly*B, and *hly*D genes of the RTX toxin cluster in the enteropathogenic *E. coli*. These *hly* genes are located on chromosome I in close proximity (downstream) to the urease gene cluster (*ure*DABCEFG) and *trh*. Immediately upstream are two ORFs encoding transposases (249 and 79 amino acids) homologous to transposases in *V. parahaemolyticus* (97% identity) and *V. cholerae* (88% identity). Scaffolds carrying these *hly* genes were ~ 8, 8 and 32 kb in length and the GC content (38.3%) was lower than the *V. parahaemolyticus* genome (~ 45.4%). Further work is needed to determine if this discovery represents a newly described mechanism of virulence in *V. parahaemolyticus*. Current efforts are focused on the validation of *hly*A against a large collection of *V.*

parahaemolyticus strains (N=167) and the discovery of additional candidate virulence markers.

38. Diarrhetic shellfish poisoning in Sequim Bay, Washington

Bich-Thuy L. Eberhart[1]*, Leslie Moore[1], Jerry Bortchert[2], and Vera L. Trainer[1]

[1]Environmental Conservation/Resource Enhancement and Utilization Technologies Division
Microbial Ecology & Toxicology Program
Northwest Fisheries Science Center
Seattle, WA
Bich-thuy.Le.Eberhart@noaa.gov

[2] Office of Shellfish and Water Protection Division
Washington State Department of Health
Olympia, WA

Diarrhetic Shellfish Poisoning (DSP) is caused by eating shellfish contaminated by marine toxins produced by the dinoflagellates of the genus *Dinophysis*. DSP is a mild gastrointestinal disorder with symptoms that include nausea, vomiting, diarrhea, and abdominal pain starting between 30 min to 3 h after ingestion of shellfish. These symptoms may last 2 to 3 days and recovery is usually complete with no after-effects. Health officials are particularly concerned about the potential chronic effects of the toxins that cause DSP including okadaic acid (OA) and its derivatives (DTX1, DTX2) as they have been reported to be tumor promoters through protein phosphatase inhibition. Since 2009, high numbers of *Dinophysis* and low levels of the lipophilic toxins that they produce were detected in shellfish, including mussels, clams, and oysters from the Puget Sound region and razor clams from the Washington coast. The first human illnesses due to DSP occurred in June 25, 2011, after three people ate mussels from Sequim Bay, WA. We report here the results of the first *Dinophysis* monitoring program in conjunction with rapid toxin screening methods as an early warning of shellfish toxicity in Washington State. This work is a collaboration of NOAA, the Washington State Department of Health, SoundToxins program volunteers, and the US Food and Drug Administration. Toxins at levels up to 10 fold above the European Union regulatory limit of 16 ug/ 100g tissues were measured using an enzyme-linked immuno-sorbent assay and confirmed by liquid chromatography and mass spectrometry.

39. Patterns of *Vibrio parahaemolyticus* concentrations in oysters, water, and plankton in Puget Sound and relationship to covariates and incidence of illness

Rohinee Paranjpye[1], William Nilsson[1],Owen Hamel[2]*, Martin Liermann[3]

[1]Environmental Conservation/Resource Enhancement and Utilization Technologies Division
Northwest Fisheries Science Center
Seattle, WA

[2]Fishery Resource Analysis and Monitoring Division
Northwest Fisheries Science Center
Seattle, WA
Owen.Hamel@noaa.gov

[3]Fish Ecology Division
Northwest Fisheries Science Center
Seattle, WA

Since 1997 there has been a significant increase in *Vibrio parahaemolyticus*-related gastroenteritis from the consumption of raw oysters harvested in Washington State. While both illness and *Vibrio* concentrations peak in the summer months, little or no correlation with concentrations of total or potentially pathogenic (encoding the thermostable direct hemolysin, *tdh*) *V. parahaemolyticus* in oysters has previously been shown. We investigated the spatial and temporal patterns of concentrations in oysters, seawater, and plankton in Puget Sound, and their relationship to covariates including temperature, salinity, and chlorophyll, as well as to incidence of illness. This study involved intensive data collection at 21 shellfish growing areas throughout Hood Canal in 2007 and 2008, followed by years of work analyzing the samples and extracting genetic information, along with considerable data exploration and statistical analysis. We also analyzed a decade-long data set from the Washington State Department of Health of *V. parahaemolyticus* concentrations in oysters, water temperature, salinity, and illnesses related to consumption of oysters. The extensive two year data set is the largest of its kind, and together with the historical data provide new insights into the dynamics of *V. parahaemolyticus* and the relationship of *Vibrio* concentrations to the incidence of illness in the Pacific Northwest.

Wednesday March 14th, 3-5pm

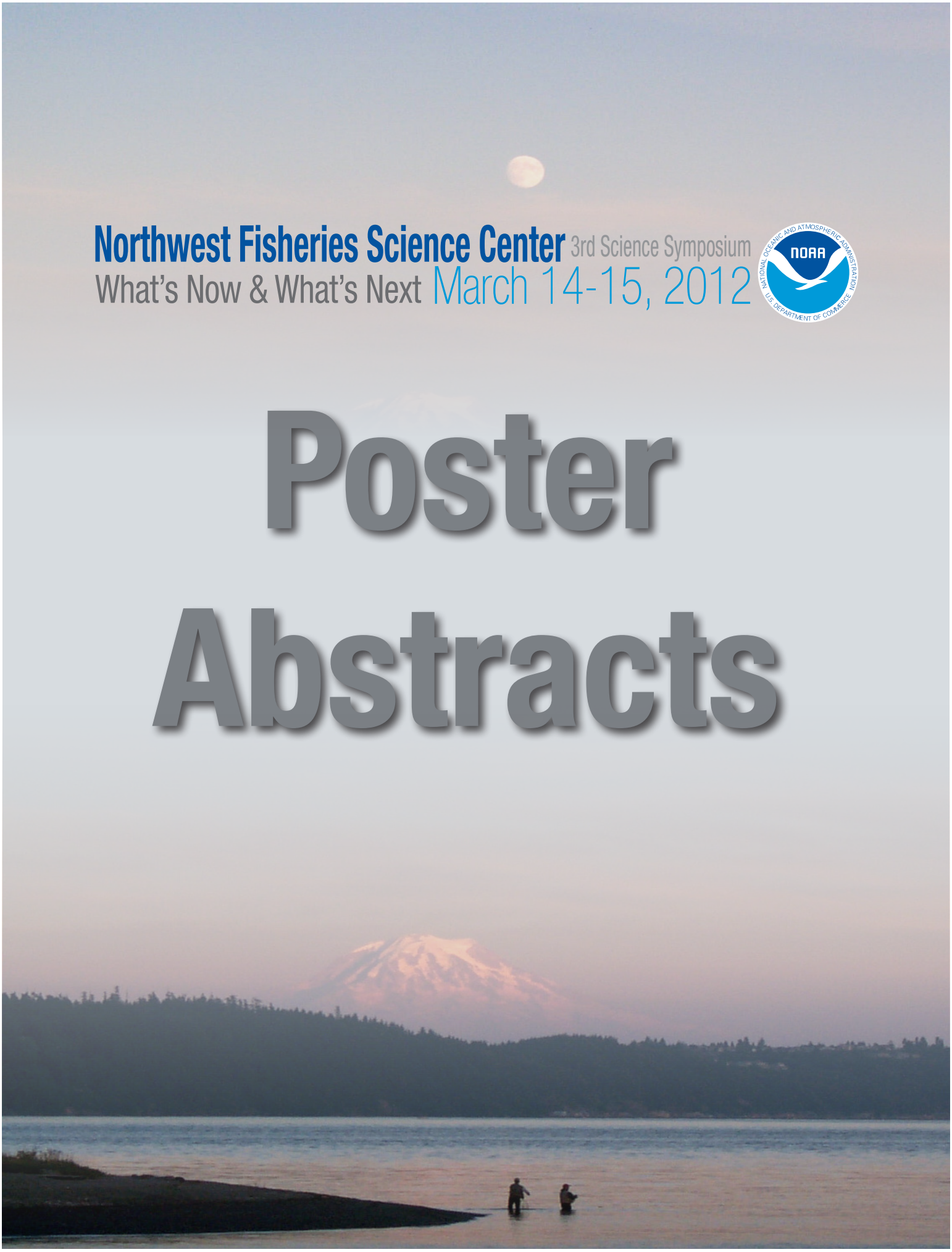
2012 NWFSC Poster Titles

	PRESENTER	DIVISION	TITLE
P-1	Bradburn, Mark	FRAM	Shedding Light on the West Coast Groundfish Bottom Trawl Survey
P-2	McElhany, Paul	CB	Ocean acidification: research at the Northwest Fisheries Science Center
P-3	Busch, Shallin	CB	An Ecoregion Perspective on Ocean Acidification: Implications for Species-Response Experiments
P-4	Norberg, Sarah	CB	Larval rockfish survival decreases in elevated CO2 environment
P-5	Russell, Suzanne	CB	Describing U.S. West Coast Commercial Fishing Communities by Targeted Fish Species and Commonly Used Fishing Gears
P-6	Tolimieri, Nick	CB	Consequences of a decline mean trophic level in the California Current Ecosystem
P-7	Williams, G.D.	CB	Status and trends of non-fisheries threats in the California Current large marine ecosystem (CCLME)
P-8	Baldwin, David H.	EC	Assessing the accuracy of a model of land use-related coho spawner mortality in Puget Sound lowland streams
P-9	Barnas, Katie	CB	Salmon Habitat Restoration: Are we putting the right types of projects in the right watersheds?
P-10	Bosley, Keith L.	FRAM	Relating groundfish biomass, species richness and community structure to the presence of corals and sponges using NWFSC bottom trawl survey data
P-11	Draper, Doug	FRAM	Methods for standardizing the U.S. West Coast Groundfish Trawl Survey
P-12	Elz, Anna	CB	Human-mediated Life History Evolution in Snake River Fall Chinook?
P-13	Keller, Aimee A.	FRAM	Variation in demersal biomass based on the U.S. west coast bottom trawl survey
P-14	Macneale, Kate	EC	Water quality – a key component of overall habitat quality for salmon and their prey in urban and urbanizing watersheds
P-15	Wakefield, Waldo	FRAM	Pacific coast-wide comparative maps of bathymetry and seafloor habitat types in 2005 and 2011
P-16	Albaugh, Andrew M.	CB	Web-based, Integrated Database Systems and How They Help Large Scale Population Management: The Ongoing Effort to Restore the Pacific Northwest Salmonids
P-17	Al-Humaidhi, A.W.	FRAM	Observed and estimated bycatch of green sturgeon and Pacific eulachon in 2002-2010 U.S. west coast fisheries.
P-18	Barnhart, Matt	FRAM	Recent Developments: Southern California Shelf Rockfish Survey
P-19	Doctor, Katy	REUT	The Hood Canal Steelhead Project: A watershed-scale experiment to assess the demographic, ecological, and genetic impacts of supplementation on natural steelhead
P-20	Faulkner, James R.	FE	Modeling Fish Guidance Efficiency and Spillway Passage at Hydroelectric Dams Using Detections of PIT Tags in Juvenile Bypass Systems
P-21	Frick, Kinsey E.	FE	Adult salmon movements in previously inaccessible habitat in the Elwha River
P-22	Guzman, Jose M	REUT	Development of tools to study the reproductive endocrine system of sablefish *Anoplopoma fimbria*
P-23	Harstad, Deborah	REUT	Early male maturation of hatchery-reared summer Chinook salmon in the upper Columbia Basin
P-24	Head, Melissa	FRAM	An ongoing study by the Northwest Fisheries Science Center's West Coast Groundfish Bottom Trawl Survey investigating the composition, distribution and abundance of anthropogenic marine debris
P-25	Iwamoto, Eric	CB	Examining 80 year old scales to determine if Columbia River kokanee are reservoirs of extinct sockeye salmon genetic diversity
P-26	Lee, Jon	REUT	Early Life History of Hatchery-Reared Lingcod Released into Puget Sound
P-27	May, Darren	REUT	Tributary and Acclimation Site Specific Patterns of Olfactory mRNA Expression In a Spring Chinook Salmon Population
P-28	Moore, Megan	REUT	Survival of Hood Canal steelhead smolts in the Salish Sea
P-29	Reyes-Tomassini, Jose	REUT	The feeding response of sablefish larva to low and high prey densities
P-30	Schwenke, Piper	CB	Asymmetrical hybridization of *Sebastes maliger* into *Sebastes caurinus,* and *Sebastes auriculatus* in the Puget Sound Basin, Washington
P-31	Watson, Katie	FRAM	Outreach Tools Used in the Implementation of the West Coast Groundfish Trawl Catch Share Program
P-32	Winans, Gary	CB	A genetic inventory of marine organisms of the Salish Sea
P-33	Adams, Nick	EC	The Ecophysiology and Toxicity of *Heterosigma akashiwo* in Puget Sound: A Living Laboratory Ecosystem Approach
P-34	Barnett, Harold	REUT	Economic Advantages of the Montlake Fish Meal Process
P-35	Baxter, Anne E.	REUT	Bacterial Fingerprinting in the Marine Environment
P-36	Bill, Brian	EC	Kinetics of nitrogen uptake and transient ammonium uptake response by the toxigenic diatom *Pseudo-nitzschia turgidula*
P-37	Chandler, Lisa	REUT	Marking live and dry diets with inert metal oxides to determine larval sablefish *(Anoplopoma fimbria)* diet consumption
P-38	Harding, Louisa	REUT	Effects of an environmental estrogen, ethynylestradiol, on the coho salmon pituitary transcriptome
P-39	Sylvander, Brendan	OMI, EC	Data Management and the Federal Seafood Safety Response to the *Deepwater Horizon* Oil Spill

Northwest Fisheries Science Center 3rd Science Symposium

What's Now & What's Next March 14-15, 2012

Poster Abstracts



Theme: Ecosystem Approach to Management for the California Current Large Marine Ecosystem

Posters 1-7

P1: Shedding light on the West Coast Groundfish Bottom Trawl Survey

Mark Bradburn

Fishery Resource and Monitoring Division
NWFSC
Seattle, WA
mark.bradburn@noaa.gov

We analyzed the relationship between near-bottom irradiance and catch per unit effort (CPUE) for multiple species encountered during an annual groundfish bottom trawl survey in 2009 and 2010. Depth and near-bottom light explained 29% of the variation in CPUE overall. Depth independently explained 27% of the variation in CPUE overall. Based on linear models conditioning for depth and latitude, there was a significant negative relationship between near-bottom light and CPUE for 14 species: arrowtooth flounder, curlfin sole, Dover sole, longnose skate, Pacific hake, plain midshipman, rex sole, sandpaper skate, shortspine thornyhead, slender sole, spiny dogfish, splitnose rockfish, spotted ratfish, white croaker hauls for hauls less than 400 m depth ($p < 0.05$). There was a significant positive relationship between light and CPUE for three species: greenstriped rockfish, halfbanded rockfish, pink seaperch ($p < 0.05$). The effect of light on CPUE varied for each species. Light had no effect on CPUE for 15 species. Light-mediated behavioral responses may determine availability of commercially important species to trawl surveys.

P2: Ocean acidification: research at the Northwest Fisheries Science Center

Paul McElhany*, D. Shallin Busch, Mike Maher, Jason Miller, Sarah Norberg and Jon Reum

Conservation Biology Division
NWFSC
Seattle, WA
paul.mcelhany@noaa.gov

Ocean acidification is primarily caused by human-derived increases in atmospheric carbon dioxide (i.e., burning of fossil fuels) that is then absorbed by the ocean, leading to chemical changes that make the ocean more acidic. Increases in ocean acidity can make it harder for many marine creatures to develop normally and survive, because changes in ocean pH can disrupt many physiological processes, include calcification in shell-producing organisms (e.g., krill, oysters, sea urchins, corals). Changes productivity of some species can ripple through the marine food chain to other species of commercial and conservation concern. Ocean acidification is considered by some one of the biggest oceanographic challenges in the coming century and has emerged as a research priority at NOAA. Northwest Fisheries Science Center (NWFSC) scientists are playing a critical role in helping the agency advance the science and manage the consequences of ocean acidification on our nation's living marine resources. Researchers at the NWFSC study ocean acidification through species-response experiments, ecosystem modeling, and field measurements of water chemistry. The NWFSC also participates in numerous outreach activities to communicate the science of ocean acidification to a diverse audience.

P3: An ecoregion perspective on ocean acidification: implications for species-response experiments

Paul McElhany and D. Shallin Busch*

Conservation Biology Division
NWFSC
Seattle, WA
shallin.busch@noaa.gov

Experiments in which organisms are reared in treatments simulating current and future pCO_2 concentrations build our understanding of the potential implications of ocean acidification for marine species. We conducted an ecoregion-scale analysis of global carbon chemistry datasets to determine appropriate pCO_2 concentrations for experimental treatments. For many species, particularly those that spend time below the surface layer, atmospheric pCO_2 concentrations are not an appropriate characterization of marine carbon chemistry. We illustrate this issue with data on the chemistry of ecoregions inhabited by two species of krill, concluding that *Euphausia pacifica* currently lives in waters with around 900 ppm pCO_2, a concentration much higher than the current global atmospheric mean. Our analysis indicates that summarizing carbon data at the ecoregion scale is useful for parameterizing species-response experiments.

P4: Larval rockfish survival decreases in elevated CO2 environment

Sarah E. Norberg*, D. Shallin Busch, Paul McElhany

Conservation Biology Division
NWFSC
Seattle, WA
sarah.norberg@noaa.gov

The effects of CO_2-driven changes in ocean carbon chemistry, or ocean acidification (OA), on shell building organisms has received much attention, but information regarding the effects of OA on fish is limited. High levels of pCO_2 in vertebrates can lead to lethal or sub-lethal hypercapnia-induced acidification of body fluids. Fish can tolerate brief exposures to high pCO_2 because of their ability to accumulate large concentrations of bicarbonate ions used for regulating acid-base balance of intracellular fluids. However, the transport of these buffering ions across cell membranes is energetically costly. Larval fish, which must meet the added daily energy requirements for growth and development, may not have enough energy to contend with the extra energetic expense of increased ion transport needed to maintain acid-base equilibrium. China rockfish (*Sebastes nebulosa*) larvae were reared in 3 different pH treatments, pH 7.70, 8.05, or 8.10. These conditions approximate past (280ppm), present (400ppm), and future (1000ppm) global average atmospheric pCO_2 levels. Larvae exposed to future pCO_2 conditions had significantly lower survival over a 20 day period (21 %) than larvae exposed to present pCO_2 conditions (70%). After two weeks of exposure to treatment conditions, larvae that survived in the future pCO_2 treatment were shorter than larvae that survived in the past and present pCO_2 treatments, though they had greater body depth than larvae in the present pCO_2 treatment. At the end of the experiment, larval size and shape was similar in all treatments. Otolith diameter relative to body size in the present (400ppm) treatment was significantly larger than the past (280ppm) and future (1000ppm) treatments by 6.5 and 4.5%, respectively. From these results, we conclude that high CO_2 conditions negatively impacted the growth, development and survival of larval China rockfish.

P5: Describing U.S. west coast commercial fishing communities by targeted fish species and commonly used fishing gears

Suzanne M. Russell[1]* and Anna Varney[2]

[1]Conservation Biology Division
Human Dimensions Program
NWFSC
Seattle, WA
Suzanne.Russell@noaa.gov

[2]Frank Orth Associates
Conservation Biology Division
Human Dimensions Program
NWFSC
Seattle, WA

The Magnuson-Stevens Fishery Conservation and Management Act (as amended thru 2007) requires various levels of social and cultural information regarding fishing communities. The first step taken by social scientists at the National Marine Fisheries Service was the development and completion of short and long form profiles for fishing communities. These profiles provide a snapshot of fishing communities by their geography. This research aims to build upon the existing profiling efforts. Additional layers of analysis expand our understanding of fishing communities. For example, species specialization, the mix of species targeted, as well as gear utilization all contribute to more in-depth descriptions of commercial fishing activity in communities. This effort also serves to provide information in a way which will be more useful to fisheries managers. Commercial fishing data is analyzed to 1) determine which fishing communities are important to a specific fisheries management plan (FMP), for example the Groundfish FMP, 2) further describe the selected communities by participation in other FMPs and species targeted, and 3) better understand the gears and gear combinations most commonly used to fish within the FMP fishery and between FMP fisheries. The organization of data in this manner will allow fisheries managers to target specific information about communities relevant to fisheries of interest. An overview of the analysis and examples of the results including GIS mapping will be provided.

P6: Consequences of a decline mean trophic level in the California Current Ecosystem

Nick Tolimieri*, Jameal Samhouri, Blake Feist andPhil Levin

Conservation Biology Division
NWFSC
Seattle, WA
nick.tolimieri@noaa.gov

Few indicators of ocean status have been rigorously examined. One exception to this rule is the meant trophic level (MTL) of fisheries catch, which measures the relative abundance of exploited species across a spectrum of trophic levels. The ubiquity and causes of a general decline in catch MTL through time have engendered much attention and debate. However, the consequences of this pattern for broader ecosystem structure and function, inclusive of unexploited species, remain virtually unexplored. Here, we use a fisheries-independent data set to document a pronounced decline in the mean trophic level of the groundfish community along the Pacific U.S. Coast from 2003-2010. We show that while groundfish biomass decreased at all trophic levels, higher trophic level fishes declined most precipitously. Using a food web model, we illustrate how these shifts in ecosystem structure may have resulted in short-term positive responses by many lower trophic level species. In the longer-term, our model predicts that initial patterns of prey release may be tempered in part by lagged responses of non-groundfish, higher trophic level species, such as seals and seabirds. Importantly, the model suggests that aggregate ecosystem functions should change little following the initial reorganization of biomass from groundfish to other components of the food web. Our findings imply that efforts to manage and conserve marine ecosystems will benefit from a fuller consideration of the information content contained within, and implied by, fisheries-independent trophic level indicators.

P7: Status and trends of non-fisheries threats in the California Current large marine ecosystem (CCLME)

G. D. Williams*, Kelly S. Andrews, Jameal Samhouri and Phil S. Levin

Conservation Biology
Ecosystem Program
NWFSC
Greg.Williams@noaa.gov

NOAA is leading the development of integrated ecosystem assessments (IEAs) throughout the United States as part of an ongoing move toward ecosystem-based management of marine and coastal resources. One focus of the IEA has been to summarize the relative risk of human activities (both ocean and land-based) that may influence the productivity of species within the CCLME. We used an exposure-sensitivity risk-analysis framework to quantify the relative risk posed by 19 non-fisheries related threats to four groundfish species. We then accumulated time series data and quantified the short-term and long-term trends of these threats in order to prioritize which ones were poised to present the greatest challenges to management in the future.
In general, we found spatially-expansive threats (e.g., climate change threats and atmospheric deposition of pollutants) posed higher risk to all species than point-source threats (e.g., nutrient input). When placed in context with climate change threats (e.g., sea surface temperature, ocean acidification), most other non-fisheries threats posed limited risk to the focal species. We found examples of both improving (e.g. inorganic pollution) and worsening (e.g. light pollution) threat trends. However, the highest risk, non-climate change threats (e.g., atmospheric deposition of pollutants, increases in sediment runoff) showed no discernible trend at this time.

Theme: Habitat
Posters 8-15

P8: Assessing the accuracy of a model of land use-related coho spawner mortality in Puget Sound lowland streams

David H. Baldwin[1]*, Julann A. Spromberg[1], Blake E. Feist[2], Eric Buhle[3], Steve Damm[4], Nathaniel L. Scholz[1]

[1] Environmental Conservation Division
NWFSC
Seattle, WA
David.Baldwin@noaa.gov

[2]Conservation Biology Division
NWFSC
Seattle, WA

[3]Fish Ecology Division
NWFSC
Seattle, WA

[4] US Fish and Wildlife Service
Lacey, WA

Monitoring efforts evaluating urban stream restoration effectiveness in the greater metropolitan area of Seattle, Washington, have detected high rates of premature mortality among adult coho salmon (*Oncorhynchus kisutch*) in restored spawning habitats. Affected animals display a consistent suite of symptoms (e.g., disorientation, lethargy, loss of equilibrium, gaping, fin splaying) that ultimately progresses to death within a few hours. Annual rates of pre-spawn mortality (PSM) observed over multiple years across several drainages have ranged from ~20% to 90% of the total fall run within a given watershed. The current understanding of coho PSM is that it occurs when pollutants accumulate on impervious surfaces during summer and early fall dry periods are washed into coho-bearing streams by fall storm events. The phenomenon seems to require both specific land uses and precipitation patterns. To evaluate the relationships between PSM, land use and precipitation patterns, we ran a series of spatial analyses to detect correlations between land cover (roadways, impervious surfaces, forests, etc.), seasonal rainfall patterns and PSM rates in 6 watersheds. Generalized linear mixed-effects models (GLMMs) were used to test the relationships between geospatial variables and coho spawner mortality. Akaike's information criterion, corrected for sample size (AICc), was used to rank the strength of evidence for each of 139 candidate models containing various combinations of predictors. The relative proportion of local roads, impervious surfaces, and commercial property in the catchment was most strongly correlated with coho PSM rates. Analyses suggest that as urban expansion continues, areas that once supported coho salmon may experience PSM rates that could jeopardize the coho salmon population viability. Using the fitted models, we built a map of predicted coho spawner mortality throughout the four counties (King, Kitsap, Pierce and Snohomish) representing much of the Puget Sound lowlands, by applying the GLMM equations to geospatial data from unmonitored basins. We are currently compiling coho spawner survey data from organizations conducting monitoring throughout the four counties to estimate the accuracy of the model predictions.

P9: Salmon habitat restoration: are we putting the right types of projects in the right watersheds?

Katie Barnas[1], David E. Hamm[2] and Monica Diaz[2]

[1]Conservation Biology Division
NWFSC
Katie.barnas@noaa.gov

[2]Pacific States Marine Fisheries Commission/Conservation Biology Division
NWFSC
Seattle, WA

Throughout the Pacific Northwest, habitat degradation has been cited as a factor contributing to the decline of Pacific Salmon. Thus, habitat restoration is widely used in hopes of increasing salmon populations with billions of dollars spent to date on restoration projects. Yet, studies suggest that projects meant to restore freshwater habitat do not always take into account local ecological concerns or impairments. Over 10 years after the majority of salmon ESA listings, we now have the datasets required to spatially compare whether restoration projects (PNSHP and PCSRF databases) match documented ecological needs (habitat assessments and recovery plans) at the TRT population scale. We use the Salmon Habitat and Project Evaluator (SHAPE) metric as a way of measuring the appropriateness of projects implemented within a watershed for all populations with completed recovery plans/ assessments in the Northwest region. This method provides an objective way to retrospectively assess restoration types and placement, evaluate the appropriateness of proposed projects based on documented ecological concerns, and to support recovery plan evaluation.

P10: Relating groundfish biomass, species richness and community structure to the presence of corals and sponges using NWFSC bottom trawl survey data

Keith L. Bosley[1]*, Katelyn M. Bosley[2], Curt E. Whitmire[1] and Aimee A. Keller*[3]

[1]Fishery Resource Analysis and Monitoring Division
NWFSC
Newport, OR
keith.bosley@noaa.gov

[2]Department of Fisheries and Wildlife
Oregon State University
Newport, OR

[3]Fishery Resource Analysis and Monitoring Division
NWFSC
Seattle, WA

Some cold-water corals and sponges occur in such dense aggregations that they provide structurally complex habitats which support a diverse assemblage of associated invertebrates and fish. In many cases, marine fishes have been linked to the presence of epibenthic invertebrates, although the specific nature of this relationship is often unknown. The Northwest Fisheries Science Center's West Coast Groundfish Bottom Trawl Survey has collected approximately 250 coral specimens per year since 2006, and has identified, on average, 200 sites (of 750) per year where sponges are present. For this study we investigated the relationship between these two groups of epibenthic invertebrates and their associations with demersal fish using trawl survey data from 2003-2010, when the survey covered continental shelf and slope waters from Cape Flattery, Wash., to the Mexican border. Regression models were used to correlate fish biomass and species richness with coral and sponge densities. Fish biomass was correlated with sponge density, but the relationship was not precise ($P<0.0001$, $R^2=0.043$). No other significant correlations were uncovered among these variables. Multivariate analyses were used to assess fish community structure in relation to coral and sponge densities, and to environmental parameters including depth, latitude and bottom temperature. There were strong correlations between species composition and both depth and bottom temperature, but no strong correlations with coral or sponge densities. Indicator species analysis was done to determine species that were associated with four levels of sponge and coral densities (high, medium, low and zero). Shortspine thornyhead (SST), rosethorn rockfish and greenspotted rockfish were associated with high sponge catches, while flatfishes were typically associated with the absence of sponges. SST, dover sole, longspine thornyhead, aurora rockfish and darkblotched rockfish were associated with high coral catches, and rex sole, english sole, and greenstriped rockfish with the absence of corals. These results provide information about broad-scale associations between corals, sponges and demersal fish

that may be useful for developing studies that are specifically focused on the function of corals and sponges as habitats for fish, and the role they may play in their life-histories.

P11: Methods for standardizing the U.S. West Coast Groundfish Trawl Survey

Doug Draper[1], Victor Simon[2], Aimee Keller[2], and Beth Horness[2]

[1]Fishery Resource Analysis and Monitoring Division
NWFSC
Newport, OR
douglas.draper@noaa.gov

[2]Fisheries Resource Analysis and Monitoring Division
NWFSC
Seattle, WA

The Northwest Fisheries Science Center conducts an annual groundfish bottom trawl survey along the West Coast upper continental slope and shelf from May to October. In 2003 NOAA headquarters directed all Science Centers to standardize protocols for surveys that estimate catch per unit effort (CPUE). Consistency in sampling efficiency of trawl surveys is achieved by using accepted, clearly defined specifications and strict operational procedures. Operation protocols are summarized here including: net diagrams, construction, repair methodology and certification procedures; warp standardization and measurement; tow duration, distance-fished and speed over ground; and use of trawl mensuration instrumentation. On each haul wingspread, headrope height, trawl depth, temperature and bottom contact are measured using trawl-mounted sensors. Trawl operations are mediated and reviewed by field staff via custom-built software applications which display real-time sensor data (e.g. trawl annotations and environmental conditions) and a post-operation display of all sensor time series for evaluation and review of each tow. Both software applications promote data quality by guiding field staff workflow, minimizing data entry errors and providing for as much immediacy in operation evaluation and for corrective action as possible during and following trawling. Variation in net mensuration data for acceptable tows are described and discussed.

P12: Human-mediated life history evolution in Snake River fall Chinook salmon?

Anna Elz[1]*, Bill Arnsberg[2], Linda Park[3], Robin Waples[4]

[1] Frank Orth and Associates/ Conservation Biology Division
NWFSC
Seattle, WA
anna.elz@noaa.gov

[2]Nez Perce Tribe
Lapwai, ID

[3]Conservation Biology Division
NWFSC
Seattle, WA

[4] Science Director's Office
NWFSC
Seattle, WA

Snake River fall Chinook salmon have experienced a wide range of anthropogenic modifications to their ecosystem that could lead to an evolutionary change that potentially affects the conservation and management of this ESA listed population. Historically, juveniles migrated to sea as sub-yearling smolts, but more recently an increasing proportion of the run overwinters in the reservoirs and migrates to sea as yearlings. Evidence suggests current conditions selectively favor survival of yearling smolts, which could drive evolution of a novel life history strategy for this population. This ongoing research uses a parentage analysis to evaluate if the shift in life history is at least partially under genetic control. Since growth rate is thought to affect migration timing, the initial part of the study looks at the growth rate of juveniles from three brood years with known parent life histories (subyearling, yearling, and hatchery-forced yearlings). After controlling for other factors that can influence juvenile growth rate, we hypothesize that parents that themselves migrate to sea as subyearlings produce faster-growing offspring than parents that migrate as yearlings as expected if the trait is at least partially heritable. PIT-tagged juveniles are also investigated for movement through the hydropower system in relation to growth rate. Results of this ongoing study have important implications for current and future management of the Columbia River hydropower system.

P13: Variation in demersal biomass based on the U.S. West Coast Bottom Trawl Survey

Aimee A. Keller[1], John Buchanan[2], John Wallace[1], Victor Simon[1], Owen Hamel[1], Keith Bosley[2], Mark Bradburn[1], Ian Stewart[1], Dan Kamikawa[2], John Harms[1] Melissa Head[1], Vanessa Tuttle[1], and Doug Draper[2]

[1]Fishery Resource Analysis and Monitoring Division
NWFSC
Seattle, WA
Aimee.Keller@noaa.gov

[2]Fishery Resource Analysis and Monitoring Division
NWFSC
Newport, OR

In response to declining biomass of Northeast Pacific groundfish in the late 1990s and to improve the scientific basis for management of the fishery, the Northwest Fisheries Science Center standardized and enhanced their annual bottom trawl survey in 2003. The survey was expanded to include the entire area along the U.S. west coast at depths of 55–1280 m. Coast-wide biomass and species richness significantly decreased during the first eight years (2003–10) of this fishery-independent survey. We observed an overall tendency toward declining biomass for 62 dominant taxa combined (fishery target and nontarget species) and four of seven subgroups (including cartilaginous fish, flatfishes, shelf rockfishes, and other shelf species), despite increasing or variable biomass trends in individual species. These decreases occurred during a period of reduced catch for groundfish along the shelf and upper slope regions relative to historical rates. We used information from multiple stock assessments to aggregate species into three groups: 1) with strong recruitment, 2) without strong recruitment in 1999, and 3) with unknown recruitment level. For each group, we evaluated whether declining biomass was primarily related to depletion (using year as a proxy) or environmental factors (i.e., variation in the Pacific Decadal Oscillation). According to Akaike's information criterion, changes in aggregate biomass for species with strong recruitment were more closely related to year, whereas those with no strong recruitment were more closely related to climate. The significant decline in biomass for species without strong recruitment confirms that factors other than depletion of the exceptional 1999 year class may be responsible for the observed decrease in biomass along the U.S. west coast.

P14: Water quality – a key component of overall habitat quality for salmon and their prey in urban and urbanizing watersheds

K. H. Macneale[1*], J.A. Spromberg[1], A.A. Camp[1], S. Damm[2], J. Davis[2] and N.L. Scholz[1]

[1]Environmental Conservation Division
NWFSC
Seattle, WA
Kate.Macneale@noaa.gov

[2]US Fish and Wildlife Service
Lacey, WA

Numerous studies have documented declines in the diversity and abundance of fish and macroinvertebrate communities in urban watersheds. However, the extent to which these declines are caused by non-point source pollution as opposed to physical habitat factors remains unclear. We examined the effects of contaminants in urban stormwater on fish and macroinvertebrate communities, specifically whether exposure to contaminated sediments alters macroinvertebrate survival and whether the existing macroinvertebrate communities in urban streams provide sufficient, high quality prey for juvenile coho salmon. Using a custom built filtration system and experimental stream channels on a local Seattle stream, we exposed diverse macroinvertebrate communities to either filtered ("clean") or unfiltered (ambient) stream water for several three-week experiments. Analysis of chemistry samples indicated there were differences between treatments (e.g. reduction of polycyclic aromatic hydrocarbons and metals in filtered treatments relative to unfiltered treatments), and we observed differences in the drift behavior and survival for some sensitive macroinvertebrate taxa. Using a bioenergetics model, we assessed how the loss of these sensitive prey taxa may affect the growth of juvenile coho salmon. By applying these innovative experimental and modeling approaches to these complex systems, we will improve our understanding of how water quality may affect juvenile salmon and their prey in watersheds that are already developed as well as in watersheds that are urbanizing rapidly.

P15: Pacific coast-wide comparative maps of bathymetry and seafloor habitat types in 2005 and 2011

Chris G. Romsos[1], Joseph J. Bizzarro[2], W. Waldo Wakefield[*3], Mary M. Yoklavich[4] and Chris Goldfinger[1]

[1]College of Earth, Ocean, and Atmospheric Sciences
Oregon State University
Corvallis, OR

[2]School of Aquatic and Fishery Sciences
University of Washington
Seattle, WA

[3]Fishery Resource Analysis and Monitoring Division
NWFSC
Newport, OR

[4]Fisheries Ecology Division
Southwest Fisheries Science Center
Santa Cruz, CA

This poster provides an overview of the seafloor habitat data products developed to support Phase I of the Pacific Coast Groundfish Essential Fish Habitat (EFH) 5-year Review. Phase I focuses on determining the extent of new information available since adopting the current EFH designations and the potential for modification of these EFH designations. Initial designations were based upon best available data developed from 2002-2005; new information is defined as data produced during or after 2005. A data search was conducted, using online tools, e.g., portals, registries, and catalogs, as well as human networks, to locate and collect new bathymetry and habitat maps within the west coast EEZ . Over 300 new bathymetric surveys and 218 new habitat maps were identified. Sources of new bathymetry data include: California Fish and Game; California State University Monterey Bay; Center for Habitat Studies and the Tombolo Institute (CHS-TI); National Oceanic and Atmospheric Administration (NOAA) National Marine Sanctuaries (NMS); NOAA Ocean Explorer; NOAA National Ocean Service; National Science Foundation; Oregon State University; United States Geological Survey (USGS). Sources for new seabed habitat maps include: California State University Monterey Bay; CHS-TI; Oregon State University; Olympic Coast NMS; USGS Coastal and Marine Ecology Branch. A set of 24 comparison map plates, 12 for Bathymetry and 12 for Habitat, were developed from the results of the search. Each plate covers a unique area of the EEZ and compares the level of knowledge between Review periods in a side-by-side presentation. For cartographic purposes habitat type was simplified to Soft, Mixed, and Hard based upon original map attributes. Advances in bathymetry coverage are seen in continental slope regions of Washington and the nearshore waters of Oregon and California. Notable increases in habitat map coverage include the state waters of both Oregon and California and the northern Olympic Coast NMS.

Theme: Recovery, Rebuilding, and Sustainability of Marine and Anadromous Species

Posters 16-32

P16: Web-based, integrated database systems and how they help large scale population management: the ongoing effort to restore Pacific Northwest salmonids

Andrew M. Albaugh

Conservation Biology Division
NWFSC
Seattle, WA,
Andrew.Albaugh@noaa.gov

The Pacific Northwest is home to over 200 distinct populations of wild salmon. As it has been well documented over the previous decades the natural abundance of many of these populations have been declining throughout the Puget Sound, Columbia River basin, and coastal Oregon regions. Under the Endangered Species Act each population has the potential to be listed as threatened. The amount of data analysis that is needed to determine the listing status of these fish is immense. At the Northwest Fisheries Science Center (NOAA) we are working to streamline this data analysis effort through the creation of integrated, web based, and geographically referenced databases.

Final salmon population abundance numbers and decadal trends are reliant on a multitude of factors. These factors include spawning ground counts, carcass counts, juvenile estimates, hatchery abundance and influence, and habitat use. Our Salmon Population Summary (SPS) Database helps to give those tasked with listing and de-listing these salmon populations as much easily discernible information as possible. Furthermore, we are creating extensive data dictionaries which are created to stand alone and paint a complete picture of the intricate often misunderstood inter-agency dataflow process, as well as a complete record of final stage data management methods.

P17: Observed and estimated bycatch of green sturgeon and Pacific eulachon in 2002-2010 U.S. west coast fisheries

A.W. Al-Humaidhi[1], M.A. Bellman[2]

[1]Pacific States Marine Fisheries Commission /Fisheries Resource and Monitoring Division
NWFSC
Seattle, WA
alia.al-humaidhi@noaa.gov

[2]West Coast Groundfish Observer Program/ Fisheries Resource and Monitoring Division
NWFSC
Seattle, WA

The West Coast Groundfish Observer Program (WCGOP) is tasked with quantifying bycatch estimates in U.S. west coast groundfish fisheries as prescribed under the Magnuson-Stevens Act. This also includes providing bycatch estimates of non-salmonid fish species protected under the Endangered Species Act (ESA) in observed U.S. west coast fisheries. WCGOP provides important information to fisheries managers regarding rates and estimates of protected species encounters in these fisheries. We present observer bycatch ratios and estimated bycatch for two species listed as threatened under the ESA: green sturgeon (*Acipenser medirostris*) and Pacific eulachon (*Thaleichthys pacificus*). Bycatch estimates were provided for 2002 through 2010 for all fishery sectors observed by the WCGOP. The coast-wide green sturgeon bycatch estimate for 2010 was the second lowest estimate of all observed years. The largest estimates of green sturgeon bycatch were in the limited entry sector of the California halibut trawl fishery. Overall, green sturgeon bycatch estimates from 2003 through 2006 were higher, in contrast with bycatch estimates from 2007 through 2010, with the exception of 2009. The Pacific eulachon bycatch estimates for 2009 and 2010 were the highest estimates of all observed years. The pink shrimp (*Pandalus jordani*) trawl fishery constituted the largest source of eulachon bycatch coast-wide. Observer coverage of the pink shrimp fishery increased in 2010 with increased coverage in California and the initiation of coverage in Washington. Protected species bycatch estimates produced by the WCGOP inform managers regarding the level of risk and impact of the various fisheries, allowing for well-informed and focused efforts to preserve protected species.

P18: Recent developments: Southern California Shelf Rockfish Survey

Matt Barnhart[1]*, John Harms[2], and Jim Benante[1]

[1]Pacific States Marine Fisheries Commission/ Fisheries Resource and Analysis and Monitoring Division
NWFSC
Seattle, WA
robert.barnhart@noaa.gov

[2]Fisheries Resource and Analysis and Monitoring Division
NWFSC
Seattle, WA

The Northwest Fisheries Science Center conducts an annual hook and line survey for shelf rockfish (Genus: *Sebastes*) in the Southern California Bight. The project, which began in 2002, targets demersal rockfish species associated with rocky, untrawlable habitats that are generally not sampled well by the division's other groundfish monitoring cruises. The hook and line survey is a collaborative effort with Pacific States Marine Fisheries Commission and the sportfishing industry in southern California. The 2011 field season was the eighth year in a time series of catch-per-unit-effort data and other biological parameters that are used to calculate an index of relative abundance for several important rockfish species including bocaccio, vermilion rockfish, greenspotted rockfish, and speckled rockfish. Bocaccio and vermilion rockfish, two primary species of interest, have been encountered at over 65% of survey sites in every year of the survey. Survey personnel are currently working with the NWFSC Genetics & Evolution Program to develop separate indices of abundance for vermilion and sunset rockfish by analyzing the finclips collected from each of the vermilion rockfish complex specimens collected during sampling.

Recent efforts include expanding the collection of environmental and oceanographic data during sampling including the acquisition of seawater temperature, dissolved oxygen, salinity, and turbidity information at depth from survey sites. These data may provide informative covariates reducing uncertainty associated with the model used to estimate indices of abundance and may also be useful in tracking shifts in oceanographic regimes in the region. In addition, the past two years work has been conducted to estimate size at maturity for the vermilion, sunset, and bocaccio rockfish. Efforts to collect video habitat information and further develop genetic biopsy hooks continue to move forward. The survey is improved by its collaboration with the sportfishing industry and has strengthened the working relationship between NOAA Fisheries and stakeholders in the region.

P19: The Hood Canal Steelhead Project: a watershed-scale experiment to assess the demographic, ecological, and genetic impacts of supplementation on natural steelhead

Katy Doctor[1]*, Barry Berejikian[1], Megan Moore[1], Skip Tezak[2], Chris Tatara[1], and Rob Endicott[1]

[1]Resource Enhancement and Utilization Technologies Division
Manchester Research Station
NWFSC
Port Orchard, WA

[2]NOAA Fisheries (Retired)

In recent decades, salmon and steelhead hatcheries in the Pacific Northwest have been developed to aid in the conservation and rebuilding of depleted natural populations. The 2007 ESA-listing of Puget Sound steelhead (USOFR 2007) highlights the importance of understanding the impact of conservation hatchery programs on natural populations. The Hood Canal Steelhead Project (HCSP) formed as a collaborative effort between lead NOAA Fisheries, state, tribal, and other federal agencies, and non-profit salmon restoration groups in the Hood Canal watershed. We are currently implementing a watershed-scale experiment to address a question critical to steelhead populations throughout the Pacific Northwest: What are the demographic and genetic impacts of conservation hatchery programs on natural steelhead populations? A before-after control-impact experiment will examine the effect of indigenous broodstock supplementation on productivity, life-history, and genetic characteristics of natural steelhead populations in Hood Canal before, during, and after supplementation. The experiment contains three supplemented streams and three non-supplemented streams. Steelhead are currently being reared to smoltification (age-2) and adulthood (age-4 and -5). Data collected prior to the influence of any hatchery-origin fish suggest natural populations within Hood Canal differ in parr- and smolt-size at age, spawn timing, life history diversity, early marine survival and migration patterns.

P20: Modeling fish guidance efficiency and spillway passage at hydroelectric dams using detections of PIT tags in juvenile bypass systems

James R. Faulkner

Fish Ecology Division
NWFSC
Seattle, WA
jim.faulkner@noaa.gov

Management of endangered salmon in the Columbia River Basin depends in part on knowledge of passage behavior of migrating juveniles at hydroelectric dams. The relative rates of passage among various routes depend on dam operations, environmental conditions, and individual fish characteristics. Data from acoustic or radio tags can provide a known time and route of passage for each individual fish, but studies using active tags are limited in number and scope, and often represent a narrow range of conditions. PIT-tagged fish offer an alternative data source available for multiple species, years, environmental conditions, and dams, but with the limitation that time and route of passage are only known for fish that enter juvenile bypass systems. I propose a model that uses only detections of PIT-tagged fish in juvenile bypass systems to predict passage probabilities through bypass, spillway, and turbines. The model uses non-linear beta regression fit to Cormack-Jolly-Seber estimates of bypass probabilities as functions of water velocity, day of year, temperature, spill proportion, and surface bypass collector operation. The model jointly fits functions for spill passage probability and the conditional probability of bypass given powerhouse passage (fish guidance efficiency). The model was applied to passage data on juvenile yearling Chinook salmon and steelhead at three Snake River Dams. After accounting for spill proportion, important predictors of spillway passage were water velocity and surface collector operation, with surface collectors more important for steelhead. Important predictors of fish guidance efficiency were day of year or temperature for both species. These results highlight the important role of within and among year variation in the environment.

P21: Adult salmon movements in previously inaccessible habitat in the Elwha River

Kinsey E. Frick*[1], Sam Brenkman[2], Raymond Moses[3] and John McMillan[4]

[1]Fish Ecology Division
NWFSC
Seattle, WA
kinsey.frick@noaa.gov

[2]National Park Service
Olympic National Park
Port Angeles, WA

[3]Lower Elwha Klallam Tribe
Port Angeles, WA

[4]Pacific State Marine Fisheries Commission
Port Angeles, WA

The high-profile removal of the Elwha and Glines Canyon Dams on the Elwha River will renew access for anadromous salmonids to 70 miles of high quality habitat located primarily within the Olympic National Park. The process of concurrent dam removals began in 2011, with anticipated fish passage projected in 2014. While the long-term benefits to anadromous populations are undisputed, release of stored sediment behind the dams will temporarily elevate suspended solids and degrade existing spawning habitat and water conditions downstream of the Elwha dam. To minimize deleterious effects in the lower river, give populations an early opportunity to spawn and imprint on upstream habitats, and examine the response of anadromous fish to the newly available areas, Chinook and coho salmon were moved upstream of Elwha and Glines Canyon dams in the summer and fall, 2011. We radiotagged and tracked 20 adult Chinook salmon and 47 adult coho salmon to determine spatial and temporal spawning in tributaries and the main stem river. Redd surveys were conducted every 7-10 days in selected tributaries, and fish movements were monitored using fixed sites and mobile tracking. We observed coho salmon redds in Little River (n=63), Indian Creek (n=30), the mainstem Elwha River (n=1), and side channels of the river (n=6). Two Chinook redds were seen in the area upstream of Glines Canyon Dam. We also observed volitional fallback and subsequent spawning or migrational movement in the lower river by both species. The offspring from these relocated adults will have direct access to the Strait of Juan de Fuca in spring of 2013 and the river will be open for upstream migration when they return as adults.

P22: Development of tools to study the reproductive endocrine system of sablefish *Anoplopoma fimbria*

José M. Guzmán*, J. Adam Luckenbach and Penny Swanson

Resource Enhancement and Utilization Technologies Division
NWFSC
Seattle, WA
Jose.Guzman-Jimenez@noaa.gov

Sablefish *Anoplopoma fimbria* is ground fish native to the Pacific Ocean. Based on its high growth rate and market value, this species has been identified as an excellent candidate for marine aquaculture. However, efforts to establish an expanding, sustainable and efficient aquaculture industry for sablefish have been severely constrained by reproductive dysfunctions. Wild broodstocks often show gonadal regression when maintain in captivity, whereas, F1 cultured fish (i.e., those produced and raised in captivity) rarely show sign of maturation. To date, there is no information on the physiological process underlying the reproductive dysfunction of sablefish broodstock. The pituitary-derived gonadotropins (GTHs), follicle-stimulating hormone (FSH) and luteinizing hormone (LH) play a key role in fish reproduction. They bind and activate specific gonadotropin receptors (GTH-Rs, FSH receptor –FSHR- and LH receptor –LHR-) expressed in the gonads and regulate the synthesis of sex steroids, which are major mediators of gametogenesis, ovulation and spawning in fishes. The purpose of this study was to develop molecular (quantitative PCRs –qPCRs-, for GTHs subunits and GTH-Rs) and immunological assays (RIAs, for sex steroids), which allow the characterization of the reproductive physiology of sablefish breeders.

For molecular assays, sablefish pituitary GTH subunit and ovarian GTHR cDNAs were first sequenced. Full-length cDNAs encoding the pituitary GTHs subunits were isolated for the first time in sablefish using RACE-PCR. The nucleotide sequences of FSHβ, LHβ and GPα subunits cDNAs were 540, 930 and 645 base pair long, respectively, encoding mature peptides of 106, 115 and 98 amino acids, respectively. At the amino acid level, the highest identities (BLAST) were found with *Epinephelus merra* (88%), *Dicentrarchus labrax* (66%) and *Ophisternon engalese* (79%), for FSHβ, LHβ and GPα, respectively. Partial sequences of cDNAs encoding sablefish FSHR and LHR were isolated from the gonads using next generation, 454-pyrosequencing, and further RACE-PCR. For FSHR and LHR, the highest identities were found with *Dicentrarchus labrax* (80%) and *Acanthopagrus schlegelii* (86%), respectively. From the cDNA sequences of sablefish GTHs and GTH-Rs specifics qPCRs were developed. For immunological assays, estradiol (E2) and testosterone (T) RIAs, developed previously for *Oncohrynchus kisutch*, are being currently validated for sablefish plasma samples.

In conclusion, sablefish GTHs and GTH-Rs have been cloned and characterized for the first time, and further used to develop specific qPCRs. These, together to sex steroids

RIAs and histological approaches, will allow us to study the physiological basis underlying the reproductive dysfunction of sablefish broodstock by comparing spawner *vs.* non-spawner female breeders. Besides, the GTH and GTH-R sequences will be further used to develop recombinant GTH analogs and portray the specific reproductive role of FSH and LH in sablefish.

P23: Early male maturation of hatchery-reared summer Chinook salmon in the upper Columbia Basin

Deborah Harstad*, Brian Beckman and Don Larsen

Resource Enhancement and Utilization Technologies Division
NWFSC
Seattle, WA
deborah.harstad@noaa.gov

We began assessing the rate of early male maturation as minijacks of hatchery-reared summer Chinook salmon in the upper Columbia River Basin in 2008 and have up to three years of data for five populations. The populations we examined include the Dryden (Bys 06-08), Carlton (Bys 06-08), Similkameen (Bys 06-08) and Bonaparte (BY 08) rearing ponds and Chelan Net Pens (Bys 06-07). Minijack rates have ranged from 4 percent among males to 46 percent among males across sites and years. Differences in rearing of these populations include seasonal water temperatures and time spent in raceways, acclimation ponds or net pens. Previous studies on spring Chinook have shown that high growth rates at critical periods can provide the opportunity for initiation of early maturation. Water temperature and feeding rates in particular may contribute to differences in growth rates and contribute to variation in minijack rates. Also some genetic differences may be present across the populations as the Dryden population is sourced from Wenatchee stock of summer Chinook, the fish released from the Chelan Net Pens comes from Wells stock that returned to the hatchery facility there, and the other three populations (Carlton, Similkameen and Bonaparte) come from wild run summer Chinook that are collected as they pass Wells Dam. I will present here an examination of differences in rearing and minijack rates across these populations.

P24: An ongoing study by the Northwest Fisheries Science Center's West Coast Groundfish Bottom Trawl Survey investigating the composition, distribution and abundance of anthropogenic marine debris

Melissa Head[1*], Victor Simon[1], Aimee A. Keller[1], John Buchanan[2], Keith Bosley[2], Dan Kamikawa[2], John Harms[1], Mark Bradburn[1] and Doug Draper[2]

[1]Fishery Resource Analysis and Monitoring Division
NWFSC
Seattle, WA
Melissa.Head@noaa.gov

[2] Fishery Resource Analysis and Monitoring Division
NWFSC
Newport, OR

Although floating marine debris such as that found in the highly publicized "Great Pacific Garbage Patch" has been the focus of recent attention, debris accumulating on the sea floor has the potential to impact benthic habitats and the organisms found there as well. The Northwest Fisheries Science Center collected marine debris from 2007 – 2011 as part of the west coast groundfish survey. We focused on composition, abundance, and distribution of anthropogenic marine debris. Marine debris occurred in 1315 of 3776 tows (2011 results are preliminary), at depths that range from 55 to 1280 m, and weighed a total of 11,507 kg. Debris was categorized into broad groups such as: plastic, metal, glass, fabric, rubber, Styrofoam and other. We also classified items related to recreational and commercial fishing and the military (e.g. helmets, weapons debris, buckets etc.). Metal objects occurred most frequently with 1396 items weighing 2394 kg present in 551 tows. Plastic was frequently encountered with 1296 objects weighing 969 kg present in 675 tows. The 'other' category includes various types of material or debris that was not sorted at sea (e.g. unsorted bags of garbage, filters, electronics, unrecognizable items etc.). This group weighed 4027 kg but occurred in only 159 tows. A large portion of this weight was a trawl net estimated at 2000 kg, and caught in 2007. Fishing related debris occurred in 16.4% of the hauls where marine debris was encountered, while military debris was present in 5.9% of these hauls.

P25: Examining 80 year old scales to determine if Columbia River kokanee are reservoirs of extinct sockeye salmon genetic diversity

Eric M. Iwamoto*, James M. Myers and Richard G. Gustafson

Conservation Biology Division
NWFSC
Seattle, WA
eric.iwamoto@noaa.gov

Sockeye salmon *(Oncorhynchus nerka)* on the Columbia River have declined from a peak of approximately 4 million fish in the late 1800's to a run size that has averaged only 78,660 over the last 10 years through a combination of habitat loss, harvest and dam construction. Although much of the damage had already been done by the 1920's, sockeye numbers remained relatively high with access to much of the Upper Columbia River remaining available. In this study, we examine scales from sockeye salmon caught in the Lower Columbia River fishery in 1924 for DNA microsatellite variability in an effort to reconstruct the historical population structure of the Basin during this period. Archival scales from 630 fish were analyzed for genetic variability at 12 microsatellite loci, and compared to 17 present-day O. nerka populations—exhibiting either anadromous (sockeye salmon) or non-anadromous (kokanee) life histories—from throughout the Columbia River Basin, including areas upstream of impassable dams built subsequent to 1924. Statistical analyses identified four major genetic assemblages of sockeye salmon in the 1924 samples. Two of these putative historical groupings were found to be genetically similar to extant evolutionarily significant units (ESUs) in the Okanogan and Wenatchee rivers (pairwise FST = 0.004 and 0.002, respectively). A third historical genetic grouping was most closely aligned with contemporary sockeye salmon in Redfish Lake, Idaho, although the association was less robust (pairwise FST = 0.060). However, a fourth genetic grouping did not appear to be related to any contemporary sockeye salmon or kokanee population, assigned poorly to the O. nerka baseline, and had distinctive early return migration-timing suggesting that this group represents an historical ESU originating in headwater lakes in British Columbia that was likely extirpated sometime after 1924. The lack of a contemporary O. nerka population possessing the genetic legacy of this extinct ESU indicates that efforts to reestablish early-migrating sockeye salmon to the headwater lakes region of the Columbia River will be difficult.

P26: Early life history of hatchery-reared lingcod released into Puget Sound

Jonathan S.F. Lee[1]*, Eugene P. Tezak[2] and Barry A. Berejikian[1]

[1]Resource Enhancement and Utilization Technologies Division
Behavioral Ecology Team
Manchester Research Station
NWFSC
Port Orchard, WA
Jon.Lee@noaa.gov

[2] NOAA Fisheries (Retired)

Coastal lingcod populations have recovered, but the status of lingcod in Puget Sound, Washington, is less clear. The release of hatchery-reared lingcod may be a viable means to bolster the wild population, but needs to proceed cautiously and begin at a small scale because of potential impacts on other declining species. We are planning a Before-After-Control-Impact (BACI) experiment to quantify the costs and benefits of hatchery lingcod releases. However, for a BACI experiment to work, released fish must stay at "Impact" sites (i.e., show site fidelity) at greater rates than they move to "Control" sites. In order to guide release methods for the future BACI experiment, we conducted small-scale releases of telemetry-tagged, hatchery-reared lingcod to determine whether release age influences site fidelity.

Release age significantly affected site fidelity. One year after release, only two of the 69 subyearlings (released at 9 and 11 months of age) were detected near the release site, while 11 were detected at more distant sites. In contrast, none of the 56 yearlings (released at 17 and 21 months of age) were detected away from release sites. The greatest site fidelity was observed in the group released at 17 months of age (7 out of 30 released fish were detected at the release site one year after release). These results suggest that 17-month-old lingcod are best suited for our future BACI experiment. The variation in site fidelity among release groups, coupled with the timing of appearances at structured habitat, suggest that the preference for structured habitat, and the ability to display site fidelity to structured habitat, develops between 11 and 17 months of age in hatchery lingcod. This behavioral pattern is similar to reports on wild lingcod, suggesting that hatchery lingcod have potential to integrate and interact with wild lingcod in nature.

P27: Tributary and acclimation site specific patterns of olfactory mrna expression in a spring Chinook salmon population

Darran May[1]*, Marc A. Johnson[2] and Andrew Dittman[3]

[1]School of Aquatic and Fishery Sciences
University of Washington
Seattle, WA
darranm@u.washington.edu

[2]Corvallis Research Laboratory
Oregon Department of Fish and Wildlife
Corvallis, OR

[3]Resource Enhancement and Utilization Technologies Division
Environmental Physiology Program
NWFSC
Seattle, WA

Salmon are well known for their extraordinary homing migrations from oceanic feeding grounds back to their river of origin to spawn. These migrations are governed by olfactory discrimination of home stream odors that juvenile salmon learn (imprint to) prior to their seaward migrations. Our previous laboratory studies have suggested that one component of imprinting involves sensitization of the peripheral olfactory system to specific odorants and up-regulation of specific odorant receptor (OR) mRNAs. Therefore, we hypothesized that juvenile salmon exposed to tributary waters with distinct chemical constituents would display different patterns of OR expression. To test this hypothesis, we sampled two different cohorts (2005 and 2010) of age 1+ juvenile spring Chinook salmon reared as part of a supplementation program in the upper Yakima River, Washington. One-year-old juveniles were sampled at their central rearing hatchery (2005 only) just prior to transfer to acclimation/release sites and then again just prior to release as smolts from three different acclimation facilities (both cohorts). Using quantitative PCR, we assessed expression levels of several ORs representing distinct subfamilies of ORs expressed in the olfactory epithelium. We observed no effect of gender or genetic hatchery influence on olfactory mRNA expression but, after several weeks of rearing at different acclimation sites, smolts reared in different waters displayed distinct patterns of OR expression. Our findings were also corroborated in a separate but similar experiment sampling a single cohort of Sockeye salmon at the same age class reared in two distinct locations. These results are consistent with our hypothesis that distinct odors present in the waters of different tributaries may influence mRNA expression in the olfactory epithelium. These results may facilitate development of molecular tools for assessing imprinting and identifying critical chemical components in natural waters that are important for imprinting.

P28: Survival of Hood Canal steelhead smolts in the Salish Sea

Megan E. Moore[1*], Barry A. Berejikian[1] and Eugene P. Tezak[2]

[1]Resource Enhancement and Utilization Technologies Division
Manchester Research Station
NWFSC
Port Orchard, WA
megan.moore@noaa.gov

[2]NOAA Fisheries (Retired)

Domestication selection and direct effects of the culture environment can both cause captively-bred fish populations to survive at low rates and behave unnaturally in the wild. New conservation hatchery approaches to fish rearing seek to reduce the effects of domestication and maintain genetic resources within depressed fish populations in order to produce fish that survive and behave similarly to wild conspecifics. This study used acoustic telemetry to compare three years of migration behavior and survival rates for two wild steelhead populations to behavior and survival of two populations raised at two different conservation hatcheries located within the Hood Canal watershed. Steelhead smolts from one conservation hatchery survived at rates similar to the two wild populations, while smolts from the other conservation hatchery exhibited reduced freshwater and early marine survival. Though many rearing conditions were similar between the two hatcheries, fish density, feeding frequency, and size sorting practices differed, possibly playing an important role in regulating survival and behavior of post-release hatchery individuals. Our results suggest that hatchery-reared smolts can achieve early marine survival rates similar to wild smolt survival rates, and that migration performance of hatchery-reared steelhead may depend on the environmental conditions and practices employed during captivity.

P29: The feeding response of sablefish larva to low and high prey densities

Jose Reyes-Tomassini

Resource Enhancement and Utilization Technologies Division
Manchester Research Station
NWFSC
Port Orchard, WA
jose.reyes-tomassini@noaa.gov

Sablefish, *Anoplopoma fimbria*, is one of several species identified in the NOAA National Aquaculture Research Plan as a high-value candidate for aquaculture. However, sablefish larval feeding protocols have not been established, partly because little is known about its feeding behavior. We began a pilot study to assess the feeding behavior of sablefish larvae under high and low prey densities. We setup one tank as a low prey density treatment and another tank as a high prey density treatment. The photoperiod was artificially controlled to provide 18 hours of daylight and 6 hours of darkness. Once a day, a large feeding pulse was manually administered to the high prey density treatment. Both treatments also received a similar number of rotifers via an automatic feeder which provided constant feeding pulses at specific times of the day. The number of prey strikes and the total number of visible larvae were counted before and after a feeding pulse. During the dark phase, no food was provided and both tanks were allowed to clear any remaining live prey. The number of visible larva was also counted immediately after lights-on and sixty seconds after lights-on. After the manual feeding pulse in the high prey density treatment, striking behavior increased in frequency. However, no significant difference was observed before and after the automatic pulse in the low prey density treatment. Sixty seconds after the lights over the tank switched on, the number of larva near the surface of the water significantly increased. Data from this pilot study suggest that sablefish respond to increase food availability by increasing their strike behavior, although this response may have a threshold. The data also suggest that larval sablefish exhibit diel vertical migration, perhaps as a response to changes in light intensity.

P30: Asymmetrical hybridization of *Sebastes maliger* into *Sebastes caurinus, and Sebastes auriculatus* in the Puget Sound Basin, Washington

Piper Schwenke[1,2*], Linda Park[1] and Lorenz Hauser[2]

[1]Conservation Biology Division
Genetics and Evolution
NWFSC
Seattle, WA
piper.schwenke@noaa.gov

[2]School of Aquatic & Fishery Sciences
University of Washington,
Seattle, WA

In Puget Sound, rockfish abundance has declined and many populations have been designated vulnerable or at risk for extinction. The implications of interspecific hybridization in Puget Sound for species of concern are significant, in particular where anthropogenic influences may impact frequency of hybridization. Our objective for this project was to determine the geographic distribution of hybridization and level of introgression between copper (*Sebastes caurinus*), quillback (*S. maliger*) and brown rockfish (*S. auriculatus*) in Puget Sound, Washington. Although these three species sympatric along the Pacific Coast and in Puget Sound, there are reports of hybridization only from within Puget Sound. We analyzed sequence data of five molecular genetic markers (one mitochondrial and four nuclear) to identify hybrids in Puget Sound *S. caurinus*, *S. maliger*, and *S. auriculatus*. We found hybrids in one third of fish collected South of Admiralty Inlet in Puget Sound through all of these hybrids were later generation hybrids and no F1's detected. The pattern of introgression was asymmetrical and biased toward *S. caurinus* and *S. auriculatus* from *S. maliger*. Our results have implications for both conservation of species in Puget Sound as well as for understanding a natural evolutionary process in post glacial fjord populations.

P31: Outreach tools used in the implementation of the West Coast Groundfish Trawl Catch Share Program

Katie Watson

Fishery Resource Analysis and Monitoring Division
NWFSC
Seattle, WA
katie.watson@noaa.gov

The West Coast Groundfish Trawl Catch Share Program was implemented on January 11, 2011. This new program, known as "catch shares," has changed the way the West Coast groundfish trawl fishery operates. Instead of the traditional race for fish, the total allowable catch in the fishery is now divided into shares that are controlled by individual fishermen. These shares represent the number of pounds available to catch, and can be caught at any point during the season.

The Fishery Resource Analysis and Monitoring (FRAM) Division at the Northwest Fisheries Science Center played a key role in the implementation of the catch shares initiative, including development of the catch share observer program and economic data collection system. These programs have required careful outreach efforts to keep constituents up-to-date on the new regulations and their requirements, along with the relevant deadlines. FRAM outreach work began before the regulations were passed, and has continued through the second year of the program.

FRAM's outreach concentrated on ensuring that the pertinent information about catch shares was easily available and understandable. We mailed letters, held outreach meetings up and down the coast, created fact sheets, and put together waterproof packets to be kept on vessels. We also redesigned the observer program's website, moving from a simple page with little information available to a multi-layered site with downloadable data summaries.

These outreach efforts helped stakeholders understand how the regulations impacted their interests: what the new requirements were, how they might impact fishing operations, and what the future effects of catch shares might be. Because of the continuing requirements of catch shares, the need for specialized outreach continues in 2012. We plan to hold another set of outreach meetings in ports along the coast, along with updating fact sheets, and a completing a two-phase revision of the website to further the accessibility of information and data relating to catch shares. We would also like to evaluate our work by surveying constituents about our current outreach efforts. This will allow us to tailor future outreach plans to meet identified needs.

P32: A genetic inventory of marine organisms of the Salish Sea

Gary A.Winans[1] and Jon Baker[2]

[1]Conservation Biology Division
NWFSC
Seattle, WA
gary.winans@noaa.gov

[2]Douglas Salmometrics
Mukilteo, WA

To monitor and manage for the health of the Salish Sea marine ecosystem, we need to include information on the stock structure for a diverse array of marine organisms. Data for stock structure, i.e., the amount and pattern of genetic differentiation, provide a framework to evaluate the evolutionary potential of species, the spatial scale of local adaptation, and the potential for broad or narrow geographic response of species and communities to environmental change or disasters. Because many marine organisms have a pelagic larval stage, it is presumed tacitly that each species consists of one panmictic population and therefore evolves and can be managed as one unit. However preliminary studies of genetic variability of as diverse group of animals such as Dungeness crabs, Pacific herring, and red sea urchins in the Salish Sea indicate that genetic homogeneity among populations is not the case. We summarize available genetic information for marine plants and animals in the Salish Sea, synthesize general patterns of variability over taxa and habitats/food webs, and highlight data gaps. We argue that to understand marine ecosystem functionality and to monitor and conserve its constituent species and species stocks more studies of biodiversity are still required.

Theme: Sustaining Marine Ecosystem and Human Health
Posters 33-40

P33: The ecophysiology and toxicity of *Heterosigma akashiwo* in Puget Sound: a living laboratory ecosystem approach

Vera L. Trainer[1], William P. Cochlan[2], Charles G.Trick[3], Mark L. Wells[4], Nicolaus G. Adams[1*], Brian D. Bill[1], Julian Herndon[2], Kathleen Thornton[4], Bich-Thuy L. Eberhart[1], Emily Olesin[1], Christopher E. Ikeda[2], Brian Sutton-Quaid[3]

[1]Environmental Conservation Division
NWFSC
Seattle, WA
Vera.L.Trainer@noaa.gov

[2]Romberg Tiburon Center for Environmental Studies
San Francisco State University
Tiburon, CA

[3]The University of Western Ontario
London, Ontario
Canada

[4]University of Maine
Orono, ME

Over one half of the world's fish production for human consumption currently comes from aquaculture while wild fisheries' yields are either stable or declining. Recurring threats from the raphidophyte, *Heterosigma akashiwo* Hada (Sournia) have caused extensive damage ($2-6 million per episode) to wild and net-penned fish of Puget Sound, Washington, and are believed to be increasing in scope and magnitude in this region, and elsewhere in the world over the past two decades. The mechanism of *H. akashiwo* toxicity is not well understood. The toxic activity of *H. akashiwo* has been attributed to the production either of reactive oxygen species, brevetoxin-like compound(s), excessive mucus, or hemolytic activity, however these mechanisms are not confirmed consistently in all fish-killing events or cultured strains. The difficulty of conducting research with active, toxin-producing field populations of *H. akashiwo* have resulted in conflicting findings from those obtained in lab culture studies, thereby limiting the ability of fish farmers to respond to these episodic blooms. Our approach is to use a "living laboratory" to study *H. akashiwo* bloom ecology and toxicity using natural assemblages. Using a mobile lab at field sites where *H. akashiwo* cells are regularly found will enable us to fully characterize the toxic element(s) responsible for fish mortality, and the environmental factors influencing toxicity. The overall goal of this project is to identify the primary toxic element and the specific environmental factors that stimulate fish-killing *H. akashiwo* blooms, and thereby provide managers with the

fundamental tools needed to help reduce the frequency and toxic magnitude of these harmful algal events. This project is funded by NOAA's National Center for Coastal Ocean Science, Ecology and Oceanography of Harmful Algal Blooms Program.

P34: Economic Advantages of the Montlake Fish Meal Process

Pete Nicklason, Harold Barnett* and Mike Rust

Resource Enhancement and Utilization Technologies Division
NWFSC
Seattle, WA
Harold.Barnett@noaa.gov

A new process was developed that combines wet reduction technology, acid stabilization, and drum drying of fish waste. Products are high protein-low ash meal, oil, and other products. Addition of formic acid to deboned and semi-processed fish meat and viscera allows for short term storage at ambient temperatures. Stored acidified material can be dried when capacity is available, allowing more hours of operation that will accommodate smaller production lines. Muscle containing fish cuts such as heads, trim, and frames are first mechanically deboned. Recovered muscle tissue is cooked and decanted to produce meal cake and oil. Raw wet viscera are ground and combined with the decanter cake to form a blended meal. The blended meal can be immediately dried on a drum dryer or stabilized with o.8% formic acid and stored for later drying. The finished meal is high in protein and low in ash, and has good binding properties that allow a rugged feed particle to be extruded with no added gelatinized starch as is the case with conventional fish meal-based feeds. Fish meal made by this process has tested well in fish feeding trials when compared to fish feeds made with fishmeal meal produced by conventional means. In a separate processing line a crude gelatin fraction is extracted from bones, recovered from the meal operation, by wet heat and straining. The crude gelatin is also dried on a drum dryer.

P35: Bacterial fingerprinting in the marine environment

Anne E. Baxter*, David Berman and Linda D. Rhodes

Resource Enhancement and Utilization Technologies Division
NWFSC
Seattle, WA
anne.baxter@noaa.gov

Studies that investigate marine bacteria often focus on pathogens and extreme marine events such as hypoxia. However, bacterial communities are also important in biodegradation of organic matter and marine food webs. Advances in culture-independent methods for identifying environmental microorganisms have improved our understanding of bacterial contributions to aquatic ecosystems. We have applied a bacterial community fingerprinting technique, ARISA (Automated Ribosomal Intergenic Spacer Analysis), to water collected in Penn Cove, WA, an embayment in Whidbey Basin that receives effluent from two sewage treatment plants and is proximal to the Skagit River delta. ARISA, combined with measurements of microbial abundance and water quality, allowed us to characterize bacterial communities within the context of spatial and seasonal gradients. In this study, we found that bacterial diversity in the water column is highly influenced by the season and depth. Communities found in water collected close to sewage treatment plant outfall (STP) sites were more similar than bacterial communities collected at non-STP (NON) control sites. Furthermore, suspended particles and their associated bacteria exhibited a strong seasonal pattern. These findings demonstrate that bacterial fingerprinting and microbial studies can be useful indicators in marine ecosystem assessments.

P36: Kinetics of nitrogen uptake and transient ammonium uptake response by the toxigenic diatom *Pseudo-nitzschia turgidula*

Brian D. Bill[1,2*], William P. Cochlan[2] and Vera L. Trainer[1]

[1]Resource Enhancement and Utilization Technologies Division
Marine Biotoxins Program
NWFSC
Seattle, WA.
brian.d.bill@noaa.gov

[2]Romberg Tiburon Center for Environmental Studies
San Francisco State University
Tiburon, CA

Nitrogen uptake kinetic parameters and transient ammonium uptake capabilities of *Pseudo-nitzschia turgidula* were investigated using the N-15 isotopic tracer technique using unialgal batch cultures grown under saturating light conditions. Maximum specific uptake rates and affinity values for three nitrogen substrates: nitrate, ammonium and urea were estimated for this primarily oceanic species for the first time. Transient, or 'surge', ammonium uptake capabilities were also investigated on nitrogen-starved batch cultures. *P. turgidula* demonstrated a nitrogen uptake preference of the order: ammonium > nitrate > urea, and mean maximum uptake rates (Vmax) of 96.3, 48.5, and 12.6 x 10-3 h-1, respectively. Substrate affinity at low nitrogen concentrations was determined by the initial slope (α) of the Michaelis-Menten curve (or equivalent), and nitrogen preference followed the same order as determined with maximum uptake rates and elevated nitrogen concentrations. Values for the initial slope were 36.7, 29.4 & 0.9 x 10-3 h-1/(μg-at N L-1), respectively for the ammonium, nitrate and urea substrates. P. turgidula demonstrated a capacity for transient 'surge' uptake of ammonium during the first 3-5 minutes and this capacity declined within 0.5 h to a relatively constant rate. These are the first results to demonstrate that an oceanic isolate of *Pseudo-nitzschia* can utilize both inorganic and organic nitrogen for assimilation and has the capacity for surge uptake of ammonium. These results will be useful for managing anthropogenic inputs into marine systems and understanding the potential contributions of *P. turgidula* to phytoplankton bloom development and its toxigenic capacity in both coastal and oceanic waters.

P37: Marking live and dry diets with inert metal oxides to determine larval sablefish (*Anoplopoma fimbria*) diet consumption

Lisa F. Chandler*, Harold J. Barnett, Ronald B. Johnson, Kenneth A. Webb Jr., Michael B. Rust

Resource Enhancement and Utilization Technologies Division
NWFSC
Seattle, WA
lisa.chandler@noaa.gov

Research to develop a U. S. sablefish (*Anoplopoma fimbria*) mariculture industry is underway. Limited knowledge concerning diet preferences and nutritional requirements during larval development perpetuates low survival to juvenile stage (6-8%). A recently described technique was used to mark diets with inert metal oxides to examine consumption while weaning sablefish from rotifers to a reference microparticulate (MP). We were able to identify and quantify marker in larvae younger than previously shown with inductively coupled plasma optical emission spectrometry (ICP-OES). Larvae ingested rotifers but not MP during a cofeeding trial. Rotifer marker concentration decreased over time due to marker evacuation, while MP marker concentration increased after five minutes in water due to nutrient leaching. This methodology will facilitate larval nutrition research to design a widely accepted particle that can improve larval growth and survival while being cheaper and more convenient than live foods.

P38: Effects of an environmental estrogen, ethynylestradiol, on the coho salmon pituitary transcriptome

Louisa Harding[1*], Irvin B. Schultz[2], Jon T. Dickey[1,3], Mollie Middleton[1,3], Graham Young[1] and Penny Swanson[3]

[1]School of Aquatic and Fishery Sciences
University of Washington
Seattle, WA
lbh4@uw.edu

[2]Batelle-PNNL
Marine Science Operations
Sequim, WA

[3]Resource Enhancement and Utilization Technologies Division
NWFSC
Seattle, WA

Many environmental contaminants in sewage effluent are able to disrupt normal endocrine function and reproduction in fish. Ethynylestradiol (EE2), a synthetic estrogen present in oral contraceptives, is one of the most potent endocrine disrupting compounds in the aquatic environment. Although extensive work has been done on the effects of EE2 on the fish brain, gonad, and liver, little attention has been focused on the pituitary. The present study aims to identify effects of EE2 on pituitary function with a transcriptome–wide analysis using Illumina® sequencing. Our long term goal is to develop sensitive molecular tools for monitoring juvenile salmon for exposure to estrogenic contaminants. Individually tagged 1+ age coho salmon (Oncorhynchus kisutch) smolts were exposed to 0 or 12 ng EE2/L via tank water in duplicate tanks for 6 weeks. This exposure was designed to reflect an environmentally relevant level during the period of outmigration when salmon would potentially be exposed. Pituitary RNA from 4 females were pooled per treatment and sent for Illumina® sequencing. Illumina® reads from control and EE2 exposed libraries were aligned to a coho 454 Sequence de novo backbone and compared by RNAseq. There were 599 genes that were 2 fold or greater differentially regulated between the control and EE2 libraries almost 95% of which were upregulated in EE2 exposed fish. The most highly differentially regulated gene between the two libraries was luteinizing hormone subunit beta (LHβ). Initial analysis of pituitary transcripts by quantitative real time PCR confirmed that EE2 exposed fish had reduced pituitary FSHβ mRNA levels and LHβ levels induced 380-fold and more than 500-fold in female fish at 1 and 6 weeks respectively. These data suggest that even one-week exposure to environmentally relevant concentrations of EE2 disrupts key reproductive hormones in salmon. Funding for this project was provided by Washington SeaGrant (Project #RB49).

P39: Data Management and the federal seafood safety response to the *Deepwater Horizon* Oil Spill

Brendan Sylvander*, Martin Park and Adam Mouton

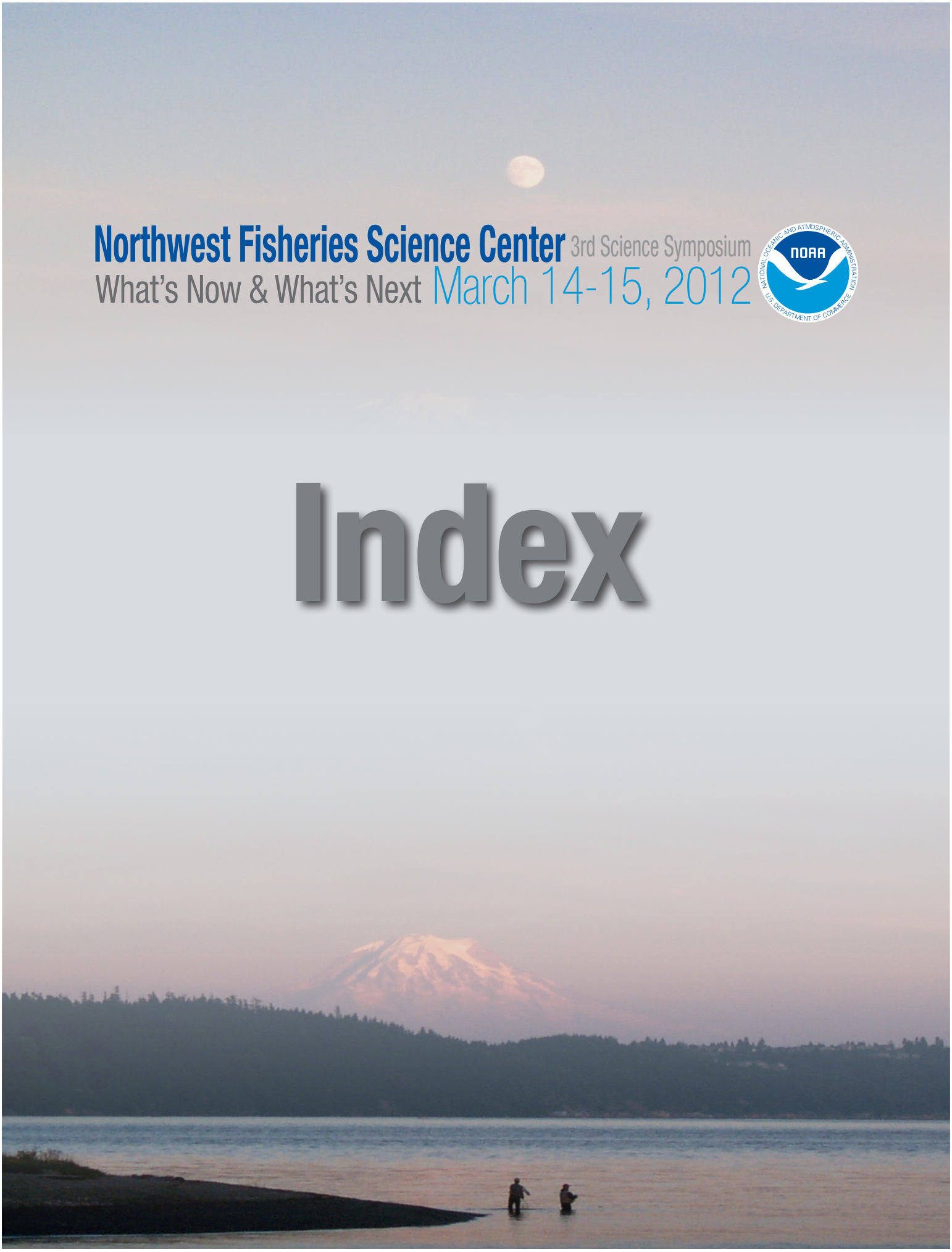
Operations, Management and Information Division
NWFSC
Seattle WA
brendan.sylvander@noaa.gov

The Scientific Data Management team (SDM) at the Northwest Fisheries Science Center (NWFSC) provides database, Geographic Information Systems (GIS), and application development services for Center staff and researchers as well as partners. To support the work of the Center in response to the *Deepwater Horizon* oil spill, SDM built an Oracle[c] database to house seafood safety sample information and analytical chemistry data. The database combined station information from the Southeast Fisheries Science Center, sensory analysis results from the Seafood Inspection Program, and analytical chemistry results from the Environmental Assessment program in the Environmental Conservation division at NWFSC. SDM built a web interface to view, query and download this information, maps and map services to display station locations by collection purpose, and [d]products to support analysis of the data. SDM also provided seafood safety data to the NOAA Office of Response and Restoration Environmental Response Management Application (ERMA).

Northwest Fisheries Science Center 3rd Science Symposium

What's Now & What's Next March 14-15, 2012

Index



Index of Authors and Presenters

Presenter indicated by bold font
P=poster